AD-A122 725 EVALUATION OF PLANNING FOR FISH AND WILDLIFE AT CORPS OF ENGINEERS RESERVOIRS RED ROCK RESERVOIR PROJECT IOWA (U) SPORT FISHING INST WASHINGTON DC NOV 82 1/2

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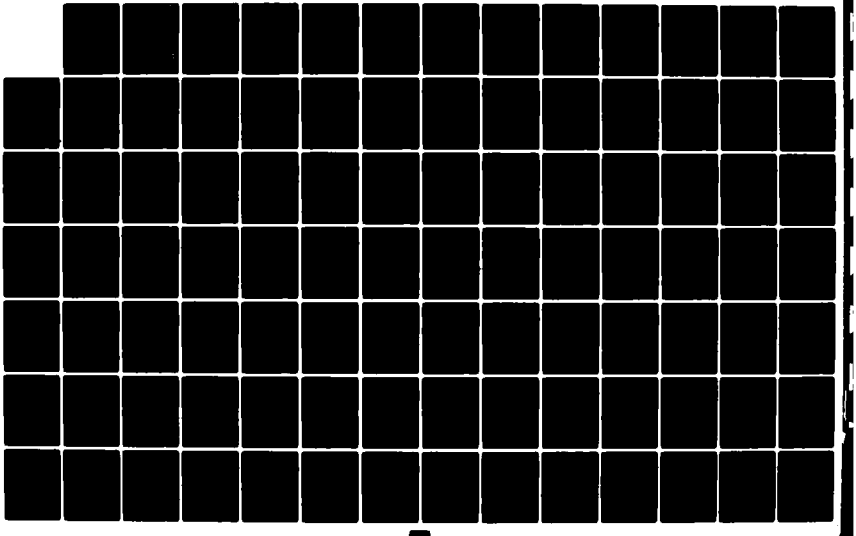

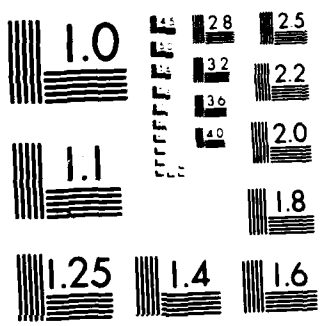

Evaluation of Planning for Fish & Wildlife

Red Rock Reservoir, Iowa
November 1982

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A122 725	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* Evaluation of Planning for Fish and Wildlife at Corps of Engineers Reservoirs, Red Rock Reservoir Project, Iowa.		5. TYPE OF REPORT & PERIOD COVERED Interim
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s) DACW 31-79-C-0005
9. PERFORMING ORGANIZATION NAME AND ADDRESS Sport Fishing Institute 108 13th Street, N.W. Washington, D.C. 20005		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Office, Chief of Engineers Washington, D.C. 20314		12. REPORT DATE October 1982
		13. NUMBER OF PAGES 129
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151, and DDC.

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

Wildlife resources	Planning recommendation
Wildlife habitat analysis	Fishery resources
Wildlife habitat management	Pre-impoundment predictions
Wildlife resource utilization	Post-impoundment occurrences
Planning evaluation	Red Rock, Iowa

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

Lake Red Rock is located on the Des Moines River 96 km (60 mi) below Des Moines, Iowa. The project was authorized to provide flood control and low flow augmentation. The authorized conservation pool covers 3,622 ha (8,950 ac) but the project has recently been operated with a conservation pool of 4,634 ha (11,540 ac) to accommodate the flow augmentation storage lost due to sedimentation. A total of 19,267 ha (47,608 ac) were acquired in fee title for project purposes.

Construction of the reservoir resulted in a significant reduction in the amount

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of cropland and the loss (1,672 ha (4,130 ac)) of flood plain woodland. On the other hand, the Red Rock Lake project created a large, public holding and created wildlife habitat unique to this area of Iowa. Comparison of aerial photographs failed to demonstrate quantifiable alteration of habitat types below the dam following completion of the project.

Mitigation activities have been greatly affected by recent changes in Corps policies and in project conditions associated with sediment storage. As a result, post-impoundment conditions for wildlife were only poorly perceived and accommodated during the planning period.

No specific mitigation lands were requested by the Iowa Conservation Commission (ICC). The opportunity to diversify wildlife habitat, with emphasis on waterfowl enhancement was welcomed by the ICC from the beginning of project plan formulation.

Recently, the ICC has used revenues generated under "condition five" of the license agreement to create sub-impoundments. Development of upland forest has received less emphasis to date, however, the availability of sustained funding should allow the ICC to implement the desired upland management program.

Lake Red Rock has silted rapidly, with a 30 percent loss of reservoir storage capacity recorded between 1969 and 1979. No note was taken of the potential silt problem in pre-construction documentation. However, two creditable recommendations were provided by the FWS early in the project development phase. These were to preserve surplus buildings, for use by the ICC, and a request for project boundary monumentation.

Current opinion of local ICC wildlife biologists is that the pre-project deer herd was probably slightly smaller or slightly larger (around 280 animals) than the current herd. Pheasants may have benefitted from the project, while the lands are believed capable of supporting fewer quail than before construction due to land use changes.

Squirrel populations suffered damage due to the elimination of bottomland hardwood, and the loss of habitat and edge have adversely affected rabbit populations. The project benefitted most aquatic and terrestrial furbearers. Long-term use of this facility by waterfowl will not be apparent for several years.

In 1960, the FWS expected approximately 12,000 hunter-days to occur on the project for deer, upland game and waterfowl. This was 67 percent more hunting effort than the 7,200 hunter-days actually estimated from field surveys conducted between September 18, 1979 and February 13, 1980.

Planning for fisheries development at the Red Rock project was almost non-existent. Both the ICC and the FWS sought to have the largest possible lake built. Sport fish management by the ICC has been limited to stocking desirable species and the supervision of the commercial fishing program.

A 1971 ICC creel survey produced a figure of 48,538 angler visits while the FWS predicted angler-use at 72,000 angler-days, annually. The tailrace supported 89 percent of the total angler-use of Lake Red Rock. CE-installed features beneficial to anglers in the tailrace greatly facilitate the heavy angler-use. The planning agencies did not address the Des Moines River fishery below the project. The lead agency's proposal to maintain a 300 cfs minimum release below the dam was apparently considered to be an adequate accommodation of the river fishery.

STUDY TO EVALUATE THE ADEQUACY AND PREDICTIVE VALUE OF FISH AND WILDLIFE PLANNING RECOMMENDATIONS AT CORPS OF ENGINEERS RESERVOIR PROJECTS

INDIVIDUAL RESERVOIR PROJECT EVALUATION REPORTS

THE RED ROCK LAKE PROJECT

Conducted for Office, Chief of Engineers, U.S. Army

By Sport Fishing Institute, Washington, D.C.

Under Contract No. DACW31-79-C-0005

PREFACE

This document was prepared by staff of the Sport Fishing Institute for the U.S. Army Corps of Engineers (CE) under contract number DACW31-79-C-0005. The contract requires the compilation and comparison of pre- and post-construction data treating fish and wildlife for twenty separate CE water development projects. This report presents the findings for one of the twenty individual project evaluations.

Upon completion of the full series of twenty separate studies, a final report will be prepared which will contain an analysis of the validity of the predictive procedures used in fish and wildlife planning, and will contain recommendations for improving fish and wildlife planning.

This evaluation of the adequacy and accuracy of fish and wildlife planning at the Red Rock Lake project in Iowa was made possible by the contributions and active cooperation of many individuals. U.S. Army Corps of Engineers personnel Frank Collins, Charles Kennedy, Terry Dowell and Teresa Herrin provided many helpful documents. Tom Nash and Bruce Stebbings, U.S. Fish and Wildlife Service's Ecological Services Division, supplied many fish and wildlife-related planning reports for the project. Several members of the Iowa Conservation Commission supplied additional descriptive information regarding current conditions for fish and wildlife communities and dependent recreational use at the Red Rock Lake project. Among these individuals were Jim Mayhew, Richard Bishop, Charles Kakac, Don Bonneau, Larry Mitzner and Jim Bruce.

An evaluation of post-impoundment wildlife resources at the Red Rock Lake project was conducted specifically to aid preparation of this report under subcontract by Lynn Braband and Dr. Robert Dahlgren of the Iowa Cooperative Wildlife Research Unit.

Dr. Keith Harmon, North Central Field Representative, Wildlife Management Institute, accompanied project personnel on a tour of the project and reviewed the draft manuscript.

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SPORT FISHING INSTITUTE

PROJECT PERSONNEL

Norville Prosser (Assistant Project Leader)

Robert Martin (Project Leader)

Gilbert Radonski (Contractor's Representative)

Naomi Higgins (Project Secretary)

CONSULTANT'S REVIEW

Professional terrestrial wildlife consultative services were provided by the staff of the Wildlife Management Institute (WMI). Project personnel were accompanied by a WMI staff specialist during field reconnaissance and on on-site discussions. The terrestrial wildlife portion of the prepared evaluative manuscript was reviewed and evaluated by WMI.

INTRODUCTION

Location

Red Rock Dam is located on the Des Moines River 230 km (143 mi) above the river's mouth and 96 km (60 mi) downstream from Des Moines, Iowa. The conservation pool is confined to Marion County. The flood control pool extends into portions of Warren, Polk, and Jasper Counties. The largest towns in the immediate vicinity of Red Rock are Knoxville (population 8,143) and Pella (population 8,349). Des Moines, Iowa, located approximately 96 km (60 mi) northeast of Red Rock Dam, is the county seat of Polk County which had a 1980 population of 303,170. Red Rock is administered by the Rock Island District of the U.S. Army Corps of Engineers.

The Des Moines River is the largest river in Iowa. The 31,916 km^2 (12,323 mi^2) watershed, above Red Rock Dam, gives a watershed to conservation pool ratio of 881:1.

Throughout the project area extensive deposits of glacial sand and gravel overlie sedimentary bedrock of shale, sandstone and limestone. Topsoils are silt and sandy silt loams which are highly productive. The topography of the project locale is gently rolling. Approximately 95 percent of the land in the Des Moines River basin is under active cultivation.

The average annual precipitation is 83.8 cm (33.0 in). The average annual temperature is 10.3°C (50.6°F).

Authorization

Lake Red Rock is a part of the Upper Mississippi River Flood Control Project which was authorized by the 1938 Flood Control Act and by the Flood Control Act of 1944. Project purposes were flood control and low flow augmentation. Initial planning was funded in 1957 and construction funds became available in 1960. Construction was completed and the lake impounded in March, 1969.

Project Description

Red Rock Dam is a rolled earthfill structure with a length of 1,730 m (5,676 ft) and a height of 33.5 m (110 ft). The reservoir covers 3,622 ha (8,950 ac) at authorized conservation pool elevation 221 m (725 ft) mean sea level (msl). At flood pool elevation 237.7 m (780 ft) msl the resulting impoundment covers 26,508 ha (65,500 ac). Land acquisition was initiated in January, 1960. The fee acquisition take line was the five-year flood frequency pool elevation 231.6 m (760 ft) msl (with Saylorville Lake in operation). To satisfy this criterion, 19,252 ha (47,572 ac) were acquired in fee title. The upper guide flowage easement acquisition was 238.7 m (783 ft) msl, 1 m (3 ft) above the maximum flood control pool. The Federal government acquired 11,394 ha (28,155 ac) in flowage easements. Pertinent project engineering data are reflected in Table 1.

Acquisition of Descriptive Reports

Correspondence files and reports relating to project planning were reviewed at several locations. Files of the U.S. Fish and Wildlife

Table 1. -- Engineering features of Lake Red Rock

Structure	Description	
Dam		
Type	Rolled earthfill	
Total length	5,676 ft	1,730 m
Height above streambed	110 ft	33.5 m
Top elevation (m.s.l.)	797 ft	243 m
Thickness at crown	44 ft	13.4 m
Thickness at base	658 ft	200.6 m
Volume of earthfill	6,500,000 yd^3	5,000,000 m^3
Spillway		
Type	Concrete ogee with tainter crest gates	
Crest length	241 ft	73.5 m
Crest elevation (m.s.l.)	736 ft	224.3 m
Tainter gate top elevation (m.s.l.)	781 ft	238.0 m
Number of tainter gates	5	5
Size of tainter gates	41 ft x 45 ft	12.5 m x 13.7 m
Outlet works		
Type	Concrete conduits through ogee	
Number of conduits	14	14
Size of conduits	5 ft x 9 ft	1.5 m x 2.7 m
Stilling basin		
Type	Concrete hydraulic jump	
Width	241 ft	73.5 m
Length	180 ft	54.9 m
Floor elevation (m.s.l.)	654 ft	199.3 m
Conservation pool		
Water surface elevation (m.s.l.)	725 ft	221.0 m
Surface area	8,950 ac	3,622 ha
Capacity	90,000 ac-ft	1.11 x $10^8 m^3$
Length	11.3 mi	18.2 km
Shoreline length	65 mi	104.6 km
Flood control pool		
Water surface elevation (m.s.l.)	780 ft	237.7 m
Surface area	65,500 ac	26,508 ha
Capacity	1,740,000 ac-ft	2.15 x $10^9 m^3$
Length	33.5 mi	54.1 km
Shoreline length	400 mi	643.7 km

Service's (FWS) Offices of Environment and Ecological Services, respectively, were reviewed at the Kansas City, Missouri Area Office and the Regional Office in Denver, Colorado. These two locations maintained the best available record of FWS involvement in planning for the Red Rock project. Red Rock Lake is administered by the U.S. Army Corps of Engineers' (CE) Rock Island District, in Rock Island, Illinois. The CE District Office was visited and the files and formal project design documents were reviewed. Historical project records also were examined at the National Archives in Washington, D.C.

Fish and wildlife-related information for the project following impoundment such as habitat analysis, studies of fish and wildlife communities, and fishing and hunting use estimates were obtained from the Iowa Conservation Commission (ICC). Fishery data gathered by the ICC for routine management purposes were adequate for purposes of this evaluation. However, insufficient data were available regarding the resident and migratory wildlife resources associated with the project. To fill this data gap, an original study of the wildlife values associated with the Red Rock project was conducted by the ICC under contract to the Sport Fishing Institute (SFI). The ICC investigation, conducted largely by staff of the Iowa Cooperative Wildlife Research Unit (ICWRU) at Iowa State University, examined changes in wildlife habitat and populations as well as hunting and trapping use of project lands during the fall and winter of 1979. The information gathered during this study was contained in a report delivered to SFI on April 4, 1980 (1).

WILDLIFE RESULTS AND DISCUSSION

Wildlife Resources -- Pre-impoundment Predictions

A sustained flow of fish and wildlife-related data were provided by the conservation agencies in response to irregular but frequent project design modifications. A summary of the early actions was provided in the FWS's comprehensive report for the Red Rock and Saylorville projects of September, 1953 (2), viz:

> In compliance with the Flood Control Act of 1938, the Corps of Engineers prepared a survey report on the Des Moines River. As a result of this survey, the Flood Control Act of 1944 approved contruction of the Red Rock Reservoir and local protection works within the City of Des Moines. A fish and wildlife report on Red Rock Reservoir was prepared in 1945 and revised in 1948. Subsequently, the Commerce Committee of the United States Senate requested the Corps of Engineers to review its original survey report on the Des Moines River, especially with a view toward ascertaining the the feasibility of reservoirs on the Raccoon and Upper Des Moines Rivers to provide flood protection for Des Moines. Proposals for the Saylorville Reservoir developed from that request and the Fish and Wildlife Service prepared a report for Saylorville Reservoir in 1949. Since preparation of these reports by the Fish and Wildlife Service, the Corps of Engineers compiled an interim report which modified operation of the reservoirs. In 1950, a letter report, evaluating these modifications, was forwarded to the Rock Island District Engineer. Because of the Corps' request to make cost data current and the need for reanalyzing the tandem effect of the project on fish and wildlife, the Fish and Wildlife Service has prepared this comprehensive report for Red Rock and Saylorville Reservoirs.

The 1953 FWS report contained what was assumed to have been accurate without-project fish and wildlife information for the Red Rock project area. However, at that time, a conservation pool of only 304 ha (750

ac) was planned by the CE, invalidating the 1953 with-project impact predictions. In 1960, the FWS released an updated fish and wildlife report on the Red Rock project (3). As requested by the CE, this document reviewed the Red Rock project under three storage options, i.e., conservation pool storage areas of 304 ha (750 ac), 2,550 ha (6,300 ac), and at the ultimately implemented area of 3,642 ha (9,000 ac). Under each scenario, land acquisition would be the same -- acquired in fee to elevation 231.6 m (760 ft), and encompass approximately 14,147 ha (35,000 ac). The FWS's 1960 report was supported and complimented by an ICC report in 1960 (4). The following discussion of without-project and predicted with-project conditions at the Red Rock project relied heavily upon the ICC and FWS 1960 reports.

The ICC report stressed habitat and wildlife community changes while the FWS report reflected project-associated impacts using the then newly adopted man-day concept. In combination, the documents allow a reasonably comprehensive understanding of pre-project conditions and predicted post-impoundment impacts.

Without-project conditions

The FWS's 1960 report did not reintroduce data on without-project conditions, concentrating instead on the probable with-project occurrences under the three storage alternatives. A general description of without-project habitat conditions appeared in the ICC's 1960 report, however, viz:

> The Des Moines River Valley included in the Red Rock project is approximately two miles wide, being bordered by low, heavily grazed, wooded slopes. Occurring in this valley are numerous channels carved by the Des Moines River in the sandy loam flood plain. Recurring floods have tended to discourage large scale farming. During the past ten years, additional clearing has been done to encompass fertile flood plain area into cultivated crop lands. The flood plain provides a multitude of cultivated fields interspersed with bottom land timber, brushy fence rows, marshes and pasture. Wildlife habitat has been reduced in this area due to intensified farming. For the most part local hunters harvest game from the valley floor with less hunting pressure directed upon the valley slopes and adjacent uplands. A greater harvest could be realized if the habitat were fully utilized by wildlife and provided recurring floods were controlled.
>
> Upland game, waterfowl and fur animals are the major groups of game providing sport and income in this area. Big game hunting has increased tremendously with the opening of the deer season in 1953. It is felt that the existing game populations in this area has determined the hunting pressure. The expected hunting potential from nearby cities and towns, would be greatly increased provided habitat requirements needed for game production could be improved in this area.

The only quantitative data in the ICC report were for big game hunting (deer) in the project area, viz:

> Deer are now common in this region and are presently increasing in numbers due to favorable habitat conditions which prevail, primarily, the interspersion of crop land with cover. While this area is not presently one of the top deer areas in the State, the basic habitat requirements necessary to foster population gains, are present. Deer are hunted in this area with an estimated 25 head harvested each year from the area encompassed by the project. These deer are primarily harvested by local hunters.

In qualitative terms, upland game were identified, however, as the most important wildlife groups in terms of hunting supported, viz:

> Upland game species provide hunters with the most hours of hunting pleasure. The wooded valley slopes and flooded plains support excellent squirrel habitat conditions, and harbor a large population. Potentially the Des Moines Valley could support a large population of cottontail rabbits, but recurring floods have kept their numbers low. More dense rabbit populations occur on the adjacent gullied uplands. Raccoon are very abundant. Ringneck pheasant habitat is inferior resulting in a low population density. Quail are the most popular game birds in the flood plain. Mourning doves are abundant during the Spring and Fall migrations with an increasing number of birds remaining in the area to nest. They are not hunted in Iowa.

Trapping of furbearers also was described in qualitative terms in the 1960 ICC report, viz:

> Muskrats are the most important aquatic fur animals. Since marshes are limited, a high percentage of muskrats dwell in bank beds resulting in a period dissemination of the population from floods. Mink are common throughout the length of all the water courses, but only the experienced trappers harvest more than two to three a season. There is very little trapping for raccoon. Most of them are caught incidentally to trapping for other aquatic fur animals. Beaver are numerous in the Des Moines River and adjacent tributaries. Weasels, opossum, coyotes and badgers are scarce.

Use of the Des Moines River by migratory and nesting waterfowl was described by the ICC as follows:

> The Red Rock impoundment is strategically located along major waterfowl flight routes in the Des Moines River Valley. The river supports no emergent vegetation. Small areas of marginal emergent and moist soil plants provide native food, but corn and small grain provide the bulk of the food. When the river is low, emerged gravel bars appear which provide resting sites for blue and snow geese. Most all species of ducks found in the Mississippi Flyway pass through the valley, while only a few woodducks, blue-wing teals and mallards remain to nest. The following species have been noted in the area; mallard, blue-wing teal, green-wing teal, pintail, baldpate, gadwall, shoveller, woodduck, ruddyduck, lesser scaup, ringneck duck, redhead, canvas-back,

bufflehead, goldeneye, Canada goose, blue goose, snow goose, mergansers, and coot.

Some waterfowl winter in the lower reaches of the Des Moines River. The average duck day for any season of the year is small. Much of the hunting of the adjacent oxbows provide waterfowl shooting during migration. The majority of the better sites are controlled by leases which exclude many of these areas to the public.

The 1953 FWS report (2) contained no quantitative without-project wildlife population or harvest information except for the following information relating to waterfowl harvest:

The average duck-day use for any season of the year is small. The waterfowl harvest seldom exceeds 1,000 birds.

With-project predictions

As noted, both the 1960 ICC and FWS reports contained predictions of fish and wildlife conditions at the Red Rock project at various conservation pool elevations, viz., 214.6 m (704 ft), 219.4 m (720 ft) and 220.9 m (725 ft). The following discussion focuses primarily on sections of these reports which predicted impacts from a conservation pool at elevation 220.9 m (725 ft) since ultimately this became the level at which the project was authorized.

In general, the ICC wanted a large impoundment as reflected in their 1960 report:

The proposed construction and operation of the Red Rock Reservoir in the flood plain included, will materially affect the wildlife habitat. Factors which will bring about changes are water impoundment levels, fluctuations, timber clearing, siltation, reduced flood-crest, intensive bottom land cultivation below the impoundment and the management of the upland area included in this project.

> The various conservation pool levels will eliminate permanent upland area in the flood plain. However, the elimination to one species will be increased in benefits to another species of game or fish, and it is felt that the value of the Red Rock Reservoir area will benefit both fish and game by the maintenance of a conservation pool of 725, which will provide maximum benefits to both fish and game.

The discussion of impacts to deer at storage elevation 220.9 m (725 ft) was couched in terms of a preceding discussion of the smaller lake at elevation 214.6 m (704 ft). Generally, the ICC believed positive habitat changes would occur as a result of public acquisition, but would be moderated by the amount of habitat permanently flooded, viz:

> Elevation 704.
>
> Values for deer would essentially be unchanged at this level, compared with present conditions if the land use pattern remains stable. However, an increase in deer population could be expected if land presently in pasture in areas unsuited for cultivation were retired from production and allowed to revert to brush. It is essential that all land suited for crops be utilized. Corn and alfalfa are especially desirable crops. It is anticipated a deer population of 1,225 deers could be expected in the Red Rock Reservoir area. A deer harvest of 250 to 300 animals would be expected annually.
>
> * * * * *
>
> Elevation 725.
>
> An additional 8,000 acres of deer habitat will be inundated at this level compared to the 704 level. This loss of deer habitat can be off-set if some of the land presently cropped or pastured is retired and allowed to revert to brush type cover. At one deer per forty acres, the terrestrial habitat could support 1,026 deer compared to the present population of about 300 animals. An anticipated annual harvest of 205 to 225 deer could be expected. Since the deer population downstream is not overly abundant at the present time. The loss

due to intensified agriculture, will probably be minor, depending on flood conditions.

The ICC's figures -- one deer per 16 ha (40 ac) and 1,026 deer -- produce 16,609 ha (41,040 ac) impact area above the expected 3,642 ha (9,000 ac) conservation pool and was within six percent of the 15,630 ha (38,622 ac) of fee lands acquired above pool elevation 221 m (725 ft) msl. Reducing the ICC's estimate of deer abundance by six percent results in an adjusted figure of 964 deer. Based on the ICC's estimate of 25-30% harvest, the corrected deer population figure (964) would produce a probable harvest of 241 to 289 deer.

The authors of the 1960 FWS report, anticipated wildlife population losses as a result of the permanent inundation of habitat. However, the federal biologists expected that the conversion of a significant area of land around the lake to public ownership would attract much higher hunting pressure, viz:

> A considerable increase in big game and upland game hunting over without-the-project conditions is to be expected regardless of the elevation of the conservation pool by virtue of the 35,000 acres of land coming into public ownership. Obviously, the larger the conservation pool the smaller will be the area in public ownership available for upland and big game hunting and potential use by hunters for these purposes will be decreased. This is not considered to be a significant drawback to a larger conservation pool since there are adequate opportunities for these kinds of hunting over much of the State.

The FWS 1960 report assumed that the area of fee acquisition would be only 14,165 ha (35,000 ac) and that approximately 3,642 ha (9,000 ac) of that area would be inundated by the conservation pool if con-

structed at elevation 221 m (725 ft). The remaining 10,522 ha (26,000 ac) were expected to support 1,300 hunter-days or 8.1 ha (20 ac) per hunter day if all lands were administered by the CE with no intensive wildlife management. Adjusting the 1960 FWS projection to accommodate the actual larger fee acquisition area above the conservation pool of 15,630 ha (38,622 ac) would provide an equivalent use figure of 1,931 deer hunter-days. The FWS noted that additional benefits would accrue to wildlife and wildlife users if project lands were administered by the ICC, although the extent was not quantified, viz:

> If the project lands and waters below the fee-taking line are made available for administration by the Iowa Conservation Commission for fish and wildlife management purposes in accordance with a General Plan, substantial additional fish and wildlife benefits will be realized.

The ICC's position relative to the expected consequences of project construction on upland game was difficult to determine from their 1960 report. The narrative language was difficult to interpret and the projected monetary losses appeared to contradict the narrative. The monetary values differed tremendously from the FWS's figures. The methods used to compute the monetary values were never identified and therefore cannot be associated with use, habitat, or population information.

Specifically, the narration in the ICC's 1960 report indicated that upland game species were expected to remain an important resource on Red Rock project lands, viz:

> Upland game production in the vicinity of the reservoir would be reduced for upland game mammals and increased for upland game birds. It is expected that such species

> as squirrel, rabbits, pheasant and quail, will be forced to abandon the valley floor for the slopes and adjacent uplands. These same species will however, benefit by a reduction in the frequency and duration and flood waters down stream. It is anticipated that the upland area management included in this project will substantiate the losses in the valley floor.

A probable inference from the above would be that the ICC expected that the production of upland game resulting from management of project lands located above the conservation pool would compensate for the loss of upland game on submerged project lands. Also, in addition, some species in stream reaches below the dam would benefit due to reduced flooding.

In contrast, the ICC's monetary figures reflected losses in hunting value for both upland game birds and other upland game animals. Although not known, the monetary values may have represented losses expected in the absence of intensive management of project lands. The without-project hunting values for upland game mammals were valued at $532.00, while projected with-the-project hunting values were -$4,498.00. The mechanism that yielded with-the-project losses 8.5 times greater than without-project values is not understood. Upland game bird hunting was given a without-project value of $1,119.00 and a with-the-project value of $744.08. All of these values were for the 221 m (725 ft) elevation conservation pool. If, as noted, the monetary values were calculated assuming with-project conditions without management, they would not be applicable to actual post-construction conditions.

Without management of project lands, hunting effort for upland game was projected to approximate 5,200 user days by the FWS in their 1960 report. Substantial, though unspecified, increases were expected with ICC management.

The ICC biologists expected a 120 to 130 percent increase in fur animal values with the Red Rock project, according to their economic data. The 1960 ICC report narrative contained the following description of probable impacts on fur animals:

> Terrestrial fur animal species such as raccoon, opossum, red fox, striped skunk, civet cat, weasel and coyote are all effected in the same manner and by the same factors as are the upland game species. The raccoon will be benefitted due to the increased number of miles of shoreline, while skunks will be the most seriously disturbed.
>
> Aquatic fur animals including muskrats, mink and beaver, will suffer temporarily, because of the radical changes in environment. It is felt that muskrats, mink and beaver, occupying bank bends during the fall, will be forced to abandon them each spring during the high water period. It is further felt that through controlled water management practices, additional areas suitable to aquatic furbearers may be developed in the Red Rock Reservoir area. Downstream from the reservoirs terrestrial and aquatic fur animal resources are expected to increase as a result of improved habitat conditions.

The 1960 FWS report predicted a modest harvest of furbearers at the Red Rock project, indicating a with-project value based on 1960 average pelt prices of $1,400. Corrected for inflation (Consumer Price Index), the 1980 equivalent value would be $3,900.

Waterfowl use of the Red Rock Lake area was expected to increase following construction. The 1960 ICC report expected increased use by spring migrants, as well as increased hunting opportunities. Oppor-

tunity for increased waterfowl production also was noted, viz:

> The proposed reservoir will create increased surface area. Each spring, the presence of large bodies of open water adjacent to agricultural land will induce an ever increasing number of waterfowl to rest on the reservoir during the spring flight. Very little native waterfowl plant food will be available and accessible. Through anticipated development projects adjacent to the upper reaches of the Red Rock Reservoir, a potential nesting area can be developed and maintained. Waterfowl hunters will certainly have bette' opportunities to harvest more waterfowl. The waterfowl use of the downstream portion, would be enhanced by the presence of the Conservation pool.

The ICC's monetary figures reflected a 60-fold increase in value for waterfowl hunting if the reservoir was ultimately constructed at elevation 221 m (725 ft).

The post-project waterfowl hunting predicted by the FWS in their 1960 report was 4,500 user days. *Interestingly*, the FWS predicted only 400 waterfowl hunter-days use if the smallest impoundment under consideration -- 303 ha (750 ac) -- were built. Assumedly, this would have been somewhat greater than hunting-use along the Des Moines River in the absence of a project.

As noted, the FWS-projected use values were those expected in the absence of game management programs. The FWS stressed the opportunity to diversify the wildlife-associated recreational values of the project area by increasing waterfowl use. This was the specific theme of several statements in the FWS's 1960 report, viz:

> However, unless the conservation pool is established at one of the two higher elevations, the potential fishery and waterfowl values will not be realized. It is in these areas, i.e. fishing and waterfowl hunting, that

this part of Iowa is most seriously deficient.

A conservation pool at elevation 725 will result in 2,700 more surface acres and an estimated 1.8 million more pounds of fish available to fishermen than a pool at elevation 720. Use by fishermen will be increased about 22,000 man-days annually. The larger pool will provide waterfowl hunters with an estimated 4,500 man-days of hunting compared to 3,100 man-days if the pool is established at 720.

* * * * *

One-fifth of Iowa's population, approximately 547,000 people, live within 50 miles of the Red Rock Reservoir site. There is a critical need for additional public waters for fishing and waterfowl hunting in central, south, and east Iowa. The State-owned lakes in this portion of Iowa receive tremendous use yet meet but a small fraction of the current demand.

Following completion of the Coralville Reservoir, on the Iowa River, 80 miles northeast of the Red Rock site, sales of fishing licenses, boats, fishing tackle and other fishing accessories virtually skyrocketed. Thousands who did little or no fishing before the reservoir was constructed are now serious fishermen. As increasing numbers of waterfowl utilize the Coralville Reservoir, hunters will use the area in growing numbers. The same hunter and fisherman response will be evident in the Des Moines area when the Red Rock Reservoir is in operation provided the conservation pool is established at one of the two higher elevations.

In summary, pre-project quantitative data were presented only for the harvest of deer (ICC), and harvest and approximate hunter-use for waterfowl (FWS). Similarly, anticipated project-associated wildlife losses and gains were qualitatively expressed by the ICC for upland game, furbearers and waterfowl resources. Quantitative post-construction projections were made by the ICC only for deer.

The ICC did develop monetary values reflective of population and hunting effort changes expected with the project. However, the means by

which the monetary values were computed were impossible to ascertain. The monetary values provided an index to the magnitude of change expected, however, for both furbearer harvest and waterfowl hunting.

Post-construction occurrences portrayed by the FWS were in terms of hunter-days for deer, upland game and waterfowl hunting. Harvest of pelts within the project area was projected in monetary terms by the FWS. A summary of the with and without-project descriptions and predictions is reflected in Table 2.

Correspondence and negotiations between the FWS and ICC and the CE continued following submittal of the former agencies 1960 reports. In October, 1962, the FWS notified the CE that Red Rock project lands were not needed for the National Wildlife Refuge program (5). The same letter contained three important recommendations that were significant for wildlife resource management at Red Rock, viz: (1) State management of project lands under a General Plan, (2) salvage and transfer of useful buildings, and (3) project monumentation. The three key paragraphs from the October, 1962 letter are presented below (op. cit.):

> We shall be glad to draft a General Plan document for review purposes as soon as you can provide us with a reservoir map on which your land acquisition boundary is delineated with suitable accuracy. We recognize that the map cannot be provided until your land acquisition negotiations are completed. To hasten review at field level, perhaps you could provide a map earlier on which an approximate taking line is marked. We could then draft a preliminary text and map for circulation and review by your office and the Iowa Commission in order to reach general agreement before the official document is drafted.

Table 2. -- Summary of wildlife-related without-project conditions and with-project predictions at Red Rock Lake project as contained in the ICC and FWS reports of 1960

Wildlife category	Reporting agency: ICC		FWS	
	Without-project	With-project	Without-project	With-project
Deer				
Population	---	975 /1	---	---
Harvest	25	244-293 /1	---	---
Hunter-days	---	---	---	1,930 /2
Upland game				
Populations				
Squirrel	Excellent /3	No change	---	---
Rabbit	Low /3	" "	---	---
Pheasant	Low /3	" "	---	---
Quail	Present /3	" "	---	---
Doves	Abundant /3	" "	---	---
Harvest	---	---	---	---
Hunter-days	---	---	---	5,200 /4
Fur bearers				
Populations				
Raccoon	Very abundant /3	---	---	---
Mink	Common /3	---	---	---
Beaver	Numerous /3	---	---	---
Weasels, opossum, coyotes, badgers	Scarce /3	---	---	---
Harvest	---	1.2-1.3 X increase /6	---	$3,900 /5
Waterfowl				
Duck-day use	Small /3	---	---	---
Harvest	---	---	1,000	---
Hunter-days	---	60 X increase /6	400	4,500 /4

/1 Corrected to reflect 5 percent less land acquired above conservation pool
/2 Corrected to reflect 49 percent more land acquired above conservation pool
/3 Only qualitative description presented by ICC
/4 Without management of project lands; substantial but unspecified increased expected if lands managed by ICC for wildlife
/5 Corrected for inflation from the 1960 value of $1,400
/6 Based upon ICC monetary values comparing without-project to with-project

> In any extensive land acquisition program of the type occurring at the Red Rock Reservoir site it is likely that buildings and other improvements will be acquired. These are normally disposed of through salvage sales or destruction. Possibly some of these improvements would be useful to the Iowa Conservation Commission in their management program. Examples of improvements which might be used for this purpose are: farm dwellings, barns, silos, grain storage sheds, garages, pumps and wells, and fences. Would it be possible to offer some of these to the State before they are destroyed or sold to provate interests at trivial costs?
>
> At many operating reservoirs public use is hampered because the boundary of the reservoir land is not clearly marked. In fact, adjacent landowners frequently preempt public reservoir lands. It has been reported that in many instances adjacent landowners and agricultural lessees of Federal reservoir lands have posted these lands and prevented public use. We hope that this problem can be avoided at Red Rock and Saylorville Reservoirs. It would help matters considerably if the boundary were marked more prominently in areas where public use would be facilitated by such markers. A row of fence posts painted distinctly and placed along the boundary line where access routes enter the reservoir land would facilitate optimum use of the public lands.

During the early 1960's two concepts developed with regard to management of project-associated wildlife lands. The state desired to manage a much larger portion of the fee lands than the CE wished to outgrant. This difference was described in a September, 1963 letter from the FWS to the ICC (6), viz:

> At a subsequent meeting in your office between Mr. Charles Chambers of this office and Messrs. William Brabham, Kenneth Madden, and others of your agency, general aspects of a proposed wildlife management plan were discussed. Your representatives proposed State management of the approximately 30,000 acres of flood pool area extending upstream from Highway 14, under provisions of a General Plan.
>
> The downstream half of the 30,000-acre area, about 15,000 acres lying between Highway 14 and Swan, would be managed as a fish nursery and waterfowl unit. The

> remaining half of the proposed general plan area, roughly 15,000 acres upstream from Swan, would be managed primarily for upland game. Some of this land could be farmed on an agricultural lease basis, and income from these leases would aid in financing fish and wildlife development and management of the area as a whole.
>
> The Rock Island District, Corps of Engineers, appears to favor a different approach to management of the area of concern. Their plan, as described to us recently by Mr. Frank Collins of that office, would involve wildlife management of one-half of the proposed General Plan area by the Corps, largely through crop manipulation under agricultural lease agreements. The Corps' plan would designate approximately one-half, or 15,000 acres, of the available area for management by the Iowa Conservation Commission under a General Plan, while maintaining the other 15,000 acres under Corps, administration.

A compromise was reached shortly thereafter in which an initial allocation to ICC of approximately one-half of the potential wildlife management lands would be followed at a later date by a similar outgrant of the remaining suitable area (7), viz:

> Approximately 30,000 acres (below elevation 760') can be made available for fish and wildlife management. Initially, about 17,000 acres of this would be made available to the Iowa Conservation Commission under terms of a General Plan. Much of the remainder will probably become available to Iowa at later dates, through supplemental agreements between the Corps of Engineers and the State. The area most suitable for wildlife management extends from the upper end of the conservation pool (at State Highway #14 crossing) upstream to elevation 760' (NB: A map of this area in question was presented as an exhibit to this memorandum).

This same 1963 memorandum outlined the FWS's understanding of the ICC's plan for eventual development of Red Rock project lands. Emphasis was expected to be placed on goose management, viz:

> The Iowa Conservation Commission has a preliminary plan to develop and manage approximately 17,000 acres primarily for waterfowl. After a period of refuge develop-

> ment and establishment of a goose flock, a public hunting area would be designated along the upstream edge of the refuge area. Emphasis would be on goose management, but other waterfowl and resident wildlife would also receive consideration in the State-managed area. In addition, about 200 acres within that area would be utilized by the Iowa Conservation Commission for fish nursery developments to produce game fish for stocking the reservoir.

A draft General Plan was submitted to the CE Rock Island District by the FWS in July, 1965. Implementation of the plan was delayed pending final resolution of the extent and location of project boundaries. Some misunderstanding appeared to exist between the affected agencies with regard to the contents of the General Plan. This matter was addressed during a telephone conversation between CE and FWS representatives in September, 1966 and summarized in an internal FWS memorandum (8), viz:

> Mr. Matthew Huppuch, Office of Chief of Engineers, called me on September 16 and said he wished to get the Bureau's [FWS] verbal approval for the Corps of Engineers to grant a "Right of Entry" to the States of Iowa and Kansas to lands at the Red Rock Reservoir, Iowa and Milford Reservoir, Kansas. The States want to plant fall crops for wildlife at the reservoirs. General Plans for both have been initiated but are being held up pending resolution of the acreage definition problem.
>
> Mr. Huppuch said that unless he could get an expression of no objection from us today (9/16) he would have to tell the District Engineer that a "Right of Entry" permit should not be granted as the fish and wildlife people were delaying the General Plan. I told Mr. Huppuch that we were not holding up the Plans but that his office was. (A General Plan for Red Rock Reservoir lands was signed by Director Speaker [ICC] on March 21, 1966, and transmitted by our Regional Office to the Corps for signature on April 14, 1966).

Within five months, the General Plan was completed and signed on April 5, 1967 (9). Lands granted to the ICC (Figure 1) under terms of the

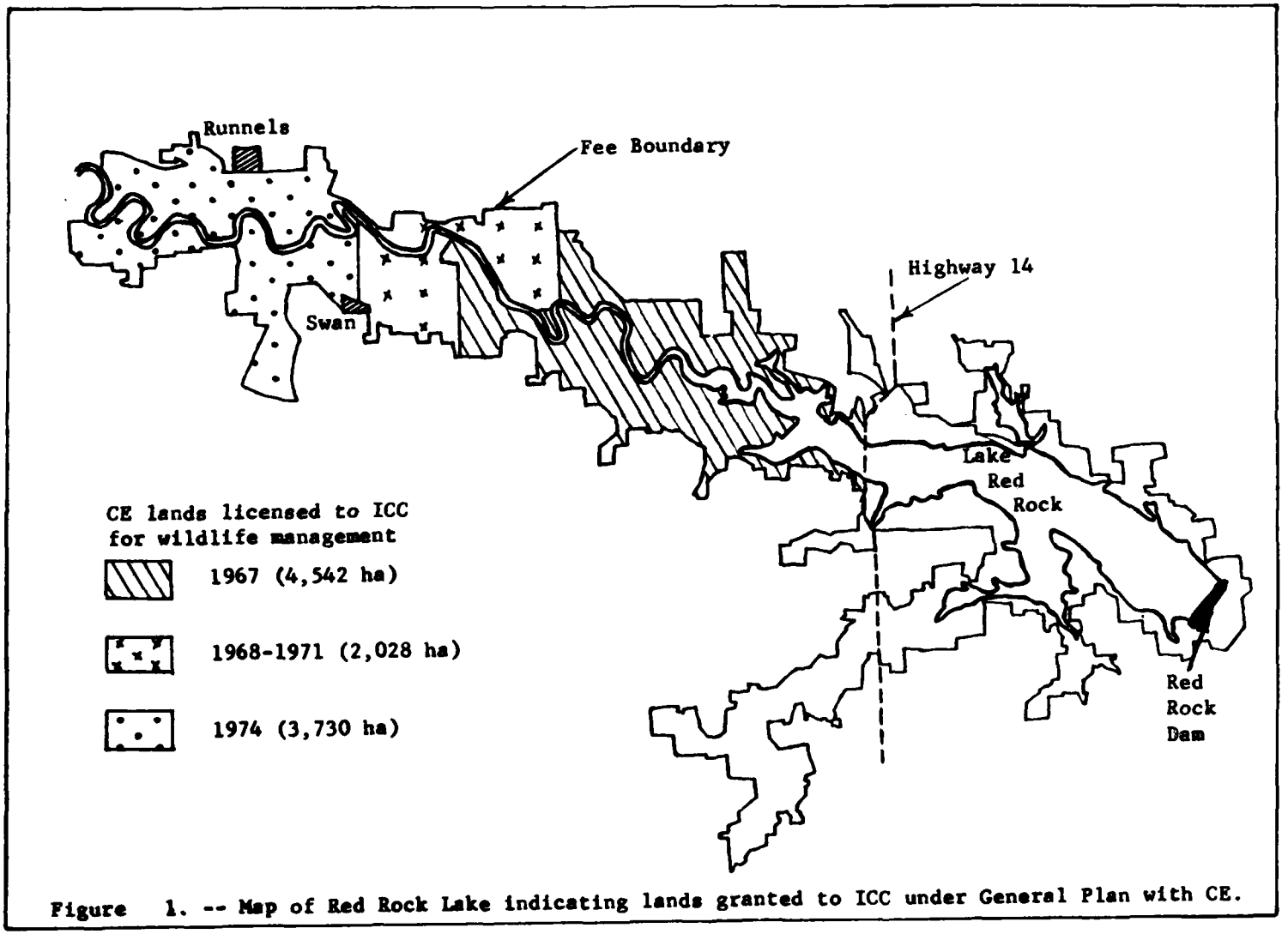

Figure 1. -- Map of Red Rock Lake indicating lands granted to ICC under General Plan with CE.

General Plan included 4,542 ha (11,222 ac) for wildlife management purposes. However, the General Plan contained the stipulation that additional project lands could be granted at a later date, viz:

> Further, in order to facilitate proper management and use of the project lands and waters, adjustments may be made in the boundaries of the areas shown on the attached exhibit by addition or deletion of tracts as may be mutually agreed upon by the District Engineer, Rock Island District, Corps of Engineers and the Director, State Conservation Commission without amendment to this General Plan. Such adjustments will be made by amendment of the aforementioned instrument.

Adjustments made in 1968, 1969 and 1971 (Figure 1), brought the outgrant to 6,570 ha (16,235 ac). In March, 1974, the final segment of 3,730 ha (9,217 ac) was allocated (Frank Collins, Chief, Environmental Resources Branch, Rock Island District, CE, pers. comm., 1981). The area currently under license to the ICC includes 10,300 ha (25,452 ac).

Construction of Red Rock Dam was completed and Red Rock Lake was impounded in March, 1969.

Wildlife Resources -- Post-impoundment Occurrences

Data were not adequate to evaluate post-impoundment wildlife associated with the Red Rock project and surrounding land. A special study was therefore designed and conducted by the Iowa Cooperative Wildlife Research Unit (ICWRU) headquartered at Iowa State University in Ames, Iowa. The study was divided into four components, viz: habitat assessment, wildlife community assessment, hunting and other use survey, and hunter harvest survey. The final report also discussed changes

in selected areas of interest by comparing pre-construction data with results of the 1980 survey. Most of the with-project discussion that follows was based upon the study just described.

Habitat analysis

An examination of project area aerial photographs (1974 and 1977) enabled the ICWRU investigators to quantify terrestrial habitat by cover type. A second step was to duplicate this process on aerial photographs taken prior to reservoir construction. Comparison of the two data sets identified project-related habitat changes in the vicinity of the Red Rock project. The ICWRU described the methods in more detail in their report (1), viz:

> Wildlife habitat changes associated with the reservoir were determined by evaluating ASCS aerial photographs taken before and after impoundment. The pre-impoundment photos were taken in 1967 and were on a 1:20,000 scale. The post-impoundment photos were taken either in 1974 (Marion and Polk Counties) or 1977 (Warren County) and are on a 1:40,000 scale. Dot grids were positioned over each photo. The dots were uniformly spaced and scaled to 25 dots/sq km (64 dots/sq mi). The number of dots in each of 12 habitat categories (cropland, upland closed and open canopy woodland, floodplain closed and open canopy woodland, upland and riparian early sere, wetland, stream channel, lake sandbars or mudflats, other) were counted.
>
> A habitat edge index was also calculated by placing a transparency of parallel lines over the photos. The lines were, to scale, approximately 149 m (400 ft) apart. The number of times lines intersected changes from one habitat category to another was counted. Only the area within the present boundaries of Red Rock Reservoir were evaluated by the grid and parallel line transparencies. The positions of the transparencies on each photo were randomly determined by spinning a pointer.

A study of habitat alterations in the flood plain zone below the Red

Rock project was also undertaken. A similar procedure was used for this analysis, as described in the ICWRU's 1980 report, viz:

> Habitat changes downstream from the reservoir were evaluated by selecting locations within 52.3 km (32.5 mi) of the dam. These locations were in Marion, Mahaska, and Wapello Counties. The pre-impoundment and post-impoundment dates for the photos were: Marion--1967 and 1974, Mahaska--1969 and 1978, and Wapello--1969 and 1978. All pre-impoundment photos were on a 1:20,000 scale while the post-impoundment scale was 1:40,000. The 52.3 km stretch of river was divided into numbered 4.0 km (2.5 mi) sections. Six locations were then selected using a table of random numbers. At each location, habitat changes were evaluated using the dot grid within a plot placed lengthwise along the river. Each plot was, to scale, 4.0 km long and 3.2 km wide, and the river's general course ran through the center of the plot. The boundaries of each plot were determined by using a template.

By converting 19,264 ha (47,600 ac) of private land to public ownership and constructing a large impoundment, certain habitat types were reduced while others were enlarged (Table 3). For example, cropland and upland early sere (herbaceous and shrubby vegetation including non-wooded pastures) were reduced by 4,552 ha (11,250 ac) while riparian early sere (annual weeds, willow thickets) increased by 3,140 ha (7,760 ac). Wetlands and upland closed canopy woodland increased by 377 ha (930 ac) and 254 ha (630 ac), respectively.

The most important habitat loss, from a wildlife perspective, was the 1,671 ha (4,130 ac) of bottomland or floodplain woodland. The ICWRU discussion of habitat changes is presented below [NB: table references have been omitted from this and subsequent quotations]:

> Probably the greatest loss of wildlife habitat associated with the reservoir was the large decrease in floodplain woodland. This habitat type has been greatly

Table 3. -- Habitat changes at Red Rock Reservoir, all public lands [based on lake at elevation 221 m (725 ft)]

Habitat	Pre-impoundment (1967)			Post-impoundment (1974;1977)			Gain or loss	
	Percent of total	Ha	(acres)	Percent of total	Ha	(acres)	Ha	(acres)
Cropland	43.3	8,337	(20,600)	27.4	5,286	(13,060)	-3,051	(-7,540)
Upland closed canopy woodland	2.8	551	(1,360)	4.2	805	(1,990)	+254	(+630)
Upland open canopy woodland	6.5	1,242	(3,070)	4.4	850	(2,100)	-392	(-970)
Floodplain closed canopy woodland	6.1	1,182	(2,920)	0.3	64	(160)	-1,118	(-2,760)
Floodplain open canopy woodland	5.4	1,040	(2,570)	2.5	486	(1,200)	-554	(-1,370)
Upland early sere[a]	19.4	3,739	(9,240)	11.7	2,238	(5,530)	-1,501	(-3,710)
Riparian early sere[b]	4.9	939	(2,320)	21.2	4,079	(10,080)	+3,140	(+7,760)
Wetland[c]	1.8	344	(850)	3.8	721	(1,780)	+377	(+930)
Stream channel	2.6	494	(1,220)	2.5	474	(1,170)	-20	(-50)
Lake	0.0	0	(0)	16.0	3,071	(7,590)	+3,071	(+7,590)
Sandbar, mudflat	2.3	450	(1,110)	3.4	656	(1,620)	+206	(+510)
Other[d]	4.9	935	(2,360)	2.6	498	(1,230)	-437	(-1,130)
Totals	100.0	19,253	(47,620)	100.0	19,228	(47,510)	--	--

[a] Herbaceous and shrubby vegetation (including non-wooded pastures).
[b] Annual weeds, willow thickets.
[c] Marshes, ponds, backwaters.
[d] Includes construction sites, buildings, lawns, roads, railroads, parking lots, vegetated mining spoils, unvegetated bluffs.
Source: Reference No. 1

> diminished throughout much of the country [10]. Most of the remaining floodplain woodland left at Red Rock is in the WMA west of Swan and much of this has been greatly disturbed by the reservoir.
>
> The acreage of upland woodland decreased following impoundment, especially on slopes facing the floodplain. The most notable change, however, was the decrease in open canopy woodland along with an increase in closed canopy woodland. This probably reflected the succession taking place within the forests as they became protected from grazing and other disturbance when brought into public ownership.
>
> Before impoundment, the vegetation type described as "riparian early sere" was limited to the peripheries of stream channels and wetlands. After impoundment, this habitat covered about 20 percent of the study area. This vegetation is made up of willows, annual weeds, and other species adapted to the severe disturbances caused by long-term flooding [11].
>
> Wetland acreage increased at Red Rock after impoundment. These wetlands included backwaters of the reservoir, oxbows, borrow pits, old farm ponds, and temporarily flooded cropland.

The 10,337 ha (25,542 ac) Red Rock Reservoir Wildlife Management Area (RRWMA) includes 69 percent of the terrestrial habitat located above the 4,209 ha (10,400 ac) recently implemented larger operating conservation pool. The RRWMA includes 84.2 percent of the remaining floodplain open canopy woodland within the project boundaries but only 38.1 percent of the upland open canopy woodland (Table 4).

The ICWRU investigators described the project-associated benefits of habitat protection associated with those project uplands that were converted from private to the public ownership, viz:

> Approximately one-fourth of the Red Rock public lands is uplands not directly affected by the reservoir (Chuck Kakac, Wildlife Biologist, ICC, 1980). One positive effect of the creation of the reservoir has been the pro-

Table 4. -- Habitat changes at Red Rock Reservoir, Wildlife Management Area [based on lake at elevation 221 m (725 ft)]

Habitat	Pre-impoundment (1967) Percent of total	Ha	(acres)	Post-impoundment (1974;1977) Percent of total	Ha	(acres)	% of total for project
Cropland	45.7	4,719	(11,660)	38.3	3,950	(9,760)	74.7
Upland closed canopy woodland	2.3	239	(590)	4.1	425	(1,050)	52.8
Upland open canopy woodland	5.3	542	(1,340)	3.2	324	(800)	38.1
Floodplain closed canopy woodland	8.2	842	(2,080)	0.4	44	(110)	68.8
Floodplain open canopy woodland	5.3	550	(1,360)	4.0	409	(1,010)	84.2
Upland early sere[a]	15.8	1,635	(4,040)	6.5	672	(1,660)	31.1
Riparian early sere[b]	6.2	635	(1,570)	25.3	2,610	(6,450)	64.0
Wetland[c]	2.4	247	(610)	6.3	648	(1,600)	89.9
Stream channel	2.9	304	(750)	4.0	417	(1,030)	88.0
Lake	0.0	0	(0)	2.2	222	(550)	7.2
Sandbar, mudflat	2.9	304	(750)	4.2	429	(1,060)	65.4
Other[d]	3.0	328	(810)	1.5	162	(400)	32.5
Totals	100.0	10,345	(25,560)	100.0	10,312	(25,480)	----

a Herbaceous and shrubby vegetation (including non-wooded pastures).

b Annual weeds, willow thickets.

c Marshes, ponds, backwaters.

d Includes construction sites, buildings, lawns, roads, railroads, parking lots, unvegetated mining spoils, unvegetated bluffs.

Source: Reference No. 1

> tection provided these uplands while wildlife habitat outside public ownership has decreased (Rick Trine and Chuck Kakac, Wildlife Biologists, ICC, 1980). For example, forest acreage in Marion County dropped by 40% between 1954 and 1974, according to statistics provided by the Forestry Section of the ICC.

As described in the 1980 ICWRU report, habitat alteration along the Des Moines River below the Red Rock project (Table 5) has not appreciably changed since construction of the reservoir, viz:

> An evaluation of habitat changes downstream from Red Rock showed very little change several years after impoundment. However, intensive agriculture had already reduced native habitats (notably floodplain forest) to low levels by 1969. The apparent small increase in floodplain woodland may have been due to the development of trees within former riparian early sere vegetation. When the floodplain woodland, riparian early sere and wetland categories are combined, there was a slight drop in floodplain habitat from pre-impoundment (10.8%) to post-impoundment (10.4%). Due to the scarcity of these habitat types, sampling size was small and the possibility of errors was greater. From the Red Rock dam to Ottumwa, the Des Moines River channel is much less sinuous than it was in the reservoir. The straight nature of the channel apparently allowed easier agricultural development. The possibility exists that the flood protection provided by Red Rock may have caused changes farther downstream, but we did not evaluate habitat changed downstream from Ottumwa. One detrimental downstream effect apparently caused by Red Rock has been increased bank erosion due to the high water volume in the channel [12].

As related earlier, the ICWRU study team evaluated ecotone or "edge" within the fee lands. This measure of habitat interspersion (Table 6) has been shown to be positively associated with wildlife communities as reported by the ICWRU in the 1980 report, viz:

> An important component of habitat quality is the amount of interspersion or "edge" of the habitat types. For many wildife species, an area increases in value when the edge among habitat types increases. Habitat edge decreased at Red Rock by almost 30 percent with the

Table 5. -- Habitat changes downstream from Red Rock Reservoir; approximately 7,705 ha (19,040 acres) sampled

Habitat	Pre-impoundment (1967, 1969)		Post-impoundment (1974, 1977)	
	Percent of total	Ha (acres)	Percent of total	Ha (acres)
Cropland	59.5	4,589 (11,340)	54.6	4,197 (10,370)
Upland closed canopy woodland	2.1	166 (410)	4.5	344 (850)
Upland open canopy woodland	5.5	425 (1,050)	5.7	441 (1,090)
Floodplain, closed canopy woodland	2.8	214 (530)	3.1	239 (590)
Floodplain, open canopy woodland	3.1	239 (590)	3.9	299 (740)
Upland early sere[a]	13.8	1,064 (2,630)	16.3	1,254 (3,100)
Riparian early sere[b]	4.1	320 (790)	2.7	210 (520)
Wetland[c]	0.8	61 (150)	0.7	53 (130)
Stream channel	4.4	336 (830)	4.5	348 (860)
Sandbar, mudflat	0.4	32 (80)	0.9	69 (170)
Other[d]	3.5	271 (670)	3.1	239 (590)
Totals	100.0	7,717 (19,070)	100.0	7,693 (19,010)

[a] Herbaceous and shrubby vegetation (including nonwooded pastures).

[b] Annual weeds, willow thickets.

[c] Marshes, ponds, backwaters.

[d] Includes buildings, lawns, roads, railroads, unvegetated mining spoils.

Source: Reference No. 1

Table 6. -- Habitat edge changes at Red Rock Reservoir

Area	Index from pre-impoundment photos (1967)	Index from post-impoundment photos (1974-1977)	Percent change
Wildlife Management Area	3,808	2,957	-22
State park, county, Corps areas	3,073	2,061	-33
All public lands	6,881	5,018	-27

Source: Reference No. 1

> formation of the reservoir. The loss of edge was least inside the WMA. Even there, the reservoir changed the character of much of the floodplain from an interspersion of cropland, woodland, and herbaceous habitats to large stands of willows and annual weeds.

Habitat management

As noted, 10,337 ha (25,542 ac) of land above the conservation pool constitutes the Red Rock Management Area and is the largest state-managed wildlife area in Iowa. The area includes a 996 ha (2,462 ac) refuge. The remaining 9,340 ha (23,080 ac) are open to hunting during the normal hunting seasons.

Management emphasis is placed on attracting migrating waterfowl, as related in the ICC's 1976 management report (13), viz:

> The area will be managed primarily for waterfowl. Large areas will be planted to corn, beans, and wheat. These crops are needed to provide the habitat necessary to attract waterfowl. The refuge, 2,462 acres, will provide a safe stopover place for waterfowl during fall migration. The refuge will keep waterfowl in the area and provide hunting opportunity for waterfowl hunters.
>
> All upland areas will be managed for quail, rabbit, squirrel, pheasants, deer and furbearers. Providing crop fields, winter cover and nesting cover will be an important part of this management. Also many non-game species will benefit from these management practices.

Problems with recurring flooding forced the ICC to alter management for the licensed lands as discussed in the 1978 management plan (14), viz:

> The area will be managed primarily for waterfowl. Current management consists of crop manipulation and a refuge to attract waterfowl. Problems with reservoir fluctuations have hampered the effectiveness of the waterfowl program. It is planned to move the refuge upstream to escape some of these reservoir fluctuations.

> Levees will be constructed and areas will be pumped to more intensively manage the area for waterfowl. This development will start this year and hopefully will be completed during the next five years. Optimum management practices will result in improved harvest conditions and increased public usage.

Management is divided between maintanence of existing improvements, and development of additional habitat and public-use facilities. The ICC's average annual management investment at Red Rock for the five-year period 1976-1980 (13, 14, 15, 16, 17) was $63,477 (Table 7). Expenditures were approximately 60 percent for maintenance and 40 percent for development.

Significant income has been generated from row crop production and a minor amount in some years from timber harvest. Of the lands most recently licensed to the ICC, some 2,000 ha (5,000 ac) were the better agricultural lands and have been sharecropped by cooperating farmers. ICC's average annual income from sharecropping has been $180,376 (13, 14, 15, 16, 17) (Table 8). The income, as authorized by Condition 5 of the ICC's license, are deposited in a special trust fund for habitat development. The major portion of these monies have been used to construct sub-impoundments to attract migrating waterfowl.

The area under sharecrop agreements has averaged 3,602 ha (8,902 ac) or nearly 35 percent of the total Red Rock area managed by the ICC (13, 14, 15, 16, 17) (Table 9). Of the lands under such agreements, approximately 50 percent are subject to periodic flooding (Chuck Kakac, ICC Wildlife Biologist, pers. comm., 1981).

Table 7. -- Iowa Conservation Commission investments on licensed project lands at Lake Red Rock project, Iowa for 1976 - 1980

Categories	Years 1976 Maint.	1976 Devel.	1977 Maint.	1977 Devel.	1978 Maint.	1978 Devel.	1979 Maint.	1979 Devel	1980 Maint.	1980 Devel	Average Maint	Average Devel.
Buildings	$ 5,472	-	$ 6,872	-	$ 8,290	-	$ 7,450	-	$12,175[3]	-	$ 8,052	-
Dams dikes and levees	1,408	-	907	-	3,160	-	8,200	-	2,900	-	3,315	-
Canals and channels	-	$ 2,688	-	$ 2,597	1,234	-	950	-	1,200	-	677	$ 1,057
Bridges	775	-	4,982[2]	-	1,495	-	2,600	-	17,700[4]	-	5,510	-
Roads	3,174	-	1,480	-	6,034	-	7,900	-	7,900	-	5,298	-
Public use facilities	5,290	377	5,593	1,018	7,780	-	7,850	-	9,300	-	7,163	279
Signs and boundary markers	4,539	-	1,374	-	-	$ 6,225	7,300	-	7,800	-	4,203	1,245
Planting trees, shrubs	-	1,260	-	1,335	-	3,601	-	$ 2,800	-	$ 3,700	-	2,539
Herbaceous seeding	-	2,535[1]	-	2,767	-	1,809	-	4,080	-	170	-	2,272
Thinning and clearing	-	3,161	-	4,425	-	4,588	-	6,300	-	-	-	3,695
Vegetation control	-	1,222	-	1,349	-	1,856	-	900	-	1,000	-	1,265
Maps, marsh management, investigations	-	242	-	339	-	500	-	-	-	1,400	-	496
Land Management	-	2,288	-	2,328	-	2,628	-	3,300	-	9,000	-	3,909
Game populations and harvest inventories	-	849	-	973	-	1,539	-	4,600	-	1,600	-	1,912
Equipment	4,769	-	5,289	-	3,411	-	4,250	-	-	3,000	3,544	600
Report, records and meetings	-	6,896	-	7,396	-	11,155	-	-	-	-	-	5,089
Fire control	223	-	450	-	-	-	-	600	-	2,400	135	600
Pumping	-	1,704	-	907	-	500	-	-	-	-	-	622
Totals	$25,650	$23,222	$26,947	$25,434	$31,404	$34,401	$46,500	$22,580	$58,975	$27,270	$37,897	$25,580
Grand Totals	$48,872		$52,381		$65,805		$69,080		$81,245		$63,477	

[1]Includes $2,054 in Condition Five trust monies
[2]Includes $4,661 in Condition Five trust monies
[3]Includes $3,975 in Condition Five trust monies
[4]Includes $16,200 in Condition Five trust monies
Source: References No. 13, 14, 15, 16, 17

Table 8. -- Receipts to Iowa Conservation Commission from crop and timber sales from lands operated under license from U.S. Army Corps of Engineers at Lake Red Rock project (1976-1980)

Source of income	1976	1977	1978	1979	1980	Average
Crops	$198,037	$153,519	$179,712	$ 86,988	$281,378	$179,927
Timber	966	923	328	-	-	449
Totals	$199,033	$154,442	$180,040	$ 86,988	$281,378	$180,376

Source: Reference No. 13, 14, 15, 16, and 17

Table 9. -- Lake Red Rock project lands under share crop agreement between Iowa Conservation Commission and local farmers from 1976-1980

	1976		1977		1978		1979*		1980		Average	
Crop	Ac	Ha	Ac	Ha	Ac	Ha	Ac	Ha	Ac	Ha	Ac	Ha
Corn	5,217	2,111	3,749	1,517	4,225	1,710	525	212	5,143	2,081	3,772	1,526
Beans	3,911	1,583	3,769	1,525	3,575	1,447	5,680	2,299	3,310	1,340	4,049	1,639
Oats	268	108	459	186	239	97	205	83	603	244	355	144
Hay	243	98	302	122	175	71	135	55	205	83	212	86
Wheat	70	28	189	76	98	40	0	0	0	0	71	29
Milo	227	92	927	375	147	59	396	160	516	209	443	179
Totals	9,936	4,020	9,395	3,801	8,459	3,424	6,941	2,809	9,777	3,957	8,902	3,603

*High water conditions experienced
Source: References No. 13, 14, 15, 16, and 17

Upland areas are managed for quail, rabbit, squirrel, pheasant, deer and furbearers. Management techniques employed include providing food, winter cover and nesting cover.

The resident CE staff also has a wildife habitat program on unlicensed project lands. Their efforts to date have resulted in 13 ha (32 ac) of prairie grasses, 19 ha (47 ac) in trees, 2.6 ha (6.5 ac) of food plots, and erecting 30 wood duck and 5 blue bird nesting boxes (Teresa Herrin, CE Ranger, pers. comm., 1981).

Within the area administered by the CE, 1,214 ha (3,000 ac) are under agricultural lease agreements. The CE requires the leasee to leave four rows of crops standing along each side of fields and refrain from hay mowing until after July 15 (op. cit).

The upper-end of the Red Rock conservation pool has gradually filled from deposits of water-borne sediment. The extent of the problem was described in a 1979 CE document (18), viz:

> Sedimentation. When Lake Red Rock went into operation in 1969, water storage capacity of the lake was estimated to be 90,000 acre-feet at a 725 conservation pool elevation. In 1979, sedimentation has reduced the estimated storage capacity to 63,400 acre-feet, a decrease of 30% of capacity in 10 years of operation.
>
> * * * *
>
> At the end of 35 years (2,014) the remaining storage capacity of Lake Red Rock would be about 1,648 acre-feet covering an area of 2,095 acres. These would be essentially marsh conditions. Such a lake could not provide significant low flow augmentation capability and would provide only limited recreation opportunities.

The sedimentation problem has led to the implementation of an experi-

mental increase in the normal pool elevation to assure adequate storage for flow augmentation. The recent history of this action is presented below (op. cit), viz:

> Initially, authorization for the pool raise was requested due to concern about a decrease in the water storage capacity of Lake Red Rock at the normal conservation pool, elevation 725 ft. msl, due to sedimentation since operation began in 1969. In 1977, it was necessary to obtain authority to reduce outflow rates and to operate the conservation pool at elevation 728 ft. msl in order to assure an adequate water supply during drought conditions prevailing at the time. Prior to raising the pool to 728 ft. msl, a severe drawdown occurred on 17 and 18 February, 1977. The pool elevation fell to 719.68 ft. msl, as a result of extremely low inflow while maintaining the required minimum outflow.
>
> In May, 1978, authority was granted to maintain Lake Red Rock at elevation 728 ft. msl during the summer of 1978. In January, 1979, this authority was extended to maintain Lake Red Rock at 728 ft. msl until completion of the Water Demand and Availability Study or until 31 December, 1979, whichever is sooner. Extension of this authority was granted subject to the preparation of an environmental assessment discussing the impacts associated with raising the conservation pool.

At elevation 222m (728 ft) Lake Red Rock permanently floods an additional 1,012 ha (2,500 ac). Some 793 ha (1,960 ac) or 78 percent of the new impounded waters lie within the wildlife lands licensed to the ICC, (op. cit), viz:

> In contrast with the main lake area, the terrain throughout the wildlife area is relatively flat, with significant areas of wetlands. At the 725 elevation, 47 percent of the shoreline is considered as wetland. The physiographic makeup of the wildlife area would remain basically unchanged as a result of raising the pool level. With its relatively flat terrain, a three-foot pool level raise within the wildlife area is surface area oriented. The water surface area would increase 1,960 acres or 76 percent, from the water surface area

of approximately 2,570 acres at the 725 pool level.

The wildlife conservation agencies, did not oppose the increased storage as reflected in the following comments prepared for the CE's EIS on the proposed action. First, the ICC area manager's, (19), viz:

> A three-foot rise in the pool level would create some negative impact on the wildlife area. Several hundred acres of floodplain fields would be permanently flooded. This will decrease the possibility of planting crops to serve as an attractant to migrating waterfowl. These fields also serve as habitat for upland game species and other wildlife. Natural drainage of some crop fields will be reduced causing more negative impacts.
>
> A three-foot rise in the pool level would also have some positive aspects. Heavy siltation the past several years has caused a reduction in water areas in the wildlife management unit. A three-foot increase would replace some of these marshy areas and attract more waterfowl to the management area. Water access to the wildlife area would also be greatly improved by a three-foot pool increase.
>
> Current proposed management plans call for moving the waterfowl refuge upstream. If these plans are carried out a three-foot water level increase would have little negative impact on the waterfowl management program. Current high water conditions and a concern that the Des Moines River will run bank full for prolonged periods due to Saylorville may cause the cancellation of our management plans concerning moving the refuge. At this time a final decision has not been made regarding moving the refuge upstream.

The FWS requested a permanent pool enlargement of even greater magnitude than was being considered by the CE (20), viz:

> There is a silting problem in the upper end of Red Rock Lake. This problem is causing some of the wildlife mitigation lands to become unsuitable for wildlife management as originally planned. Areas that were formerly good wood duck nesting sites are now mud flats due to silt replacing the water in the area. Maintaining the conservation pool level at 728 feet msl will not im-

prove this situation. Therefore, we are recommending that the conservation pool level be raised to 730 feet msl. This change would have little adverse impact on terrestrial wildlife and would actually benefit migratory birds. Also, to properly manage the mitigation lands for migratory birds the water level should be raised to 733 feet or 735 feet from September 1 until December 15.

We are concerned about downstream impacts that might result due to changing the water level of the lake. Increasing the water level in the lake will decrease the lake's capacity to hold flood waters. This could result in longer sustained bank-full discharges downstream. If this is the case, it will have an adverse impact on the habitat downstream.

An increase in storage during the fall to attract waterfowl had been requested earlier (1978) by the ICC (21), viz:

The Iowa Conservation Commission is again this year requesting your assistance in providing improved habitat conditions for migrating waterfowl by maintaining increased water levels on Lake Red Rock during fall migration.

Last year water levels were above elevation 730.0 for most of the waterfowl season. This provided excellent waterfowl habitat by creating several hundred acres of flooded willows and smartweed. As a result of these improved habitat conditions we had a large build up of ducks and a very successful waterfowl hunting season.

After last years successful hunting season, we can anticipate an increase in hunters using the Red Rock area this year. By holding the water level above elevation 730.0 during the waterfowl season (Oct. 1 - Dec. 1) both the hunter and the migrating waterfowl would benefit.

The impact of raising the storage elevation on flood control capability of the Red Rock project is minimal according to CE statements (18), viz:

Flood Control. The flood control aspects of the project will not be significantly impacted by raising the conservation pool. Flood storage capacity for Lake Red

> Rock with a conservation pool at 725 msl is 1,726,150 acre-feet. The storage capacity with a conservation pool at 728 msl will be 1,699,580 acre-feet. This represents a reduction of 1.5% in storage capacity expressed as a percent of present flood control capacity. No changes in the present project regulation plan are proposed.

Wildlife communities

Unfortunately no quantitative evaluation of wildlife communities were undertaken either before construction, as described previously, or after. In an attempt to fill the later data gap, the ICWRU undertook to define post-construction conditions for wildlife on Red Rock project lands during the 1980 study. The ICWRU's methodology was described as follows (1):

> Evaluation of the changes in wildlife populations associated with Red Rock Reservoir were limited because of data of pre-impoundment populations were scanty and detailed censusing of present wildlife populations was not practical. Instead, we endeavored to gather all available information on the wildlife of the Red Rock area both before and after impoundment and devise a general picture of changes that have occurred. Sources of this information were ICC and U.S. Army Corps of Engineers biologists, other informed persons, and what literature was available. Also, the aerial photo habitat evaluation was utilized to help in estimating changes in wildlife species associated with those habitats.

The ICWRU report reflected the dramatic increase in waterfowl use on the project following construction of the reservoir, viz:

> Use days at Red Rock were 55,000 for ducks and 16,500 for geese in 1967 and 160,000 for ducks and 46,000 for geese in 1968 [22].
>
> After the lake was formed in the spring and summer of 1969, the use of the Red Rock area by migrating waterfowl greatly increased. Use days averaged 2.4 million for ducks and 0.3 million for geese per year from 1969

> through 1974 [Charles Kakac, Wildlife Biologist, ICC, pers. comm., 1980]. Fall use of the reservoir has largely been by dabbling species and lesser scaup (Table 22). Both dabblers and divers have used Red Rock during spring migration (Table 23). [NB: Tables 22 and 23 referenced above are herein presented as Tables 10 and 11, respectively].

The inherent limitations of the Red Rock waterfowl count data were discussed by an ICC biologist, the agency that conducts the aerial counts, (Richard Bishop, Wildlife Research Supervisor, ICC, pers. comm., 1980). These comments are presented below as they relate directly to the data presented in the preceeding two tables, viz:

> ...only mallard numbers are reliable, because other species are difficult to accurately assess with our present survey techniques. However, various water conditions dictate types of ducks present and their numbers at Red Rock, thus these data are not totally accurate. Weather influences migrations of certain species and inventories often miss large early rapid movements. Use by all waterfowl species increased after impoundment.

Mid-winter counts of waterfowl have reflected greater use of the Red Rock pool than of unimpounded river sections as was discussed in the ICWRU analysis, viz:

> Red Rock is also used by wintering waterfowl. We compared Red Rock Christmas bird counts with similar counts at Oskaloosa and Ottumwa (counts for 1970, 1974-1979 are published in Iowa Bird Life or on file at the WMA headquarters or U.S. Army Corps of Engineers Red Rock headquarters) and found consistently more waterfowl at Red Rock than at the downstream locations. Before impoundment, the Red Rock winter waterfowl populations were probably similar to the present downstream populations. Most of the wintering waterfowl at Red Rock have been mallards and Canada geese plus a few common mergansers and goldeneyes.

Use of the project area by geese was described in the 1980 ICWRU report as follows:

Table 10. Peak numbers (in thousands) of ducks species at Lake Red Rock in the fall

Year	Mallard	Black duck	Gadwall	Wigeon	Pintail	GW teal	BW teal	Shoveler	Wood duck	Redhead	Canvas-back	Lesser scaup	Ring-necked	Golden-eye	Ruddy	Merganser
1969	15.0	1.5	0.5	0.3	5.0	0	4.0	1.0	4.0	0.5	0	0.2	0	0	0	0
1970	45.0	1.0	4.0	2.0	5.0	1.5	2.0	0.5	2.0	0	0	6.0	0	0	0	0.5
1971	60.0	0	1.0	5.0	4.0	5.0	1.0	1.0	3.0	0	0	0	0	0	0	0
1972	30.0	0	0	0	1.0	0.2	0	0.5	1.0	0	0	0.5	0.5	0	0	0
1973	5.0	0	0	0.5	0	2.0	3.0	0	5.0	0	0	3.0	0	0	0	0
1974	25.0	0	1.0	1.2	0.5	0	0	0	0.5	0	0	0	0	0	0	0
1975	32.0	0	0	0	0	0.3	0.2	0	0.5	0	0	0.2	0	0	0	0
1976	48.0	0	0	0	0	0	0.2	0	0.2	0	0	0.1	0	0	0	0
1977	85.0	0	1.0	1.0	1.0	7.0	1.5	0	1.5	0.1	0	2.0	0	0.2	0	0
1978	80.0	0	0	0.5	0.5	3.0	1.0	0	1.0	0	0	3.0	0	0	1.0	0.5
1979	105.0	0	0	0.2	0.4	2.3	0.4	0.2	0.2	0	0	4.0	0	0		

Source: Reference No. 22

Table 11. Peak numbers (in thousands) of duck species at Lake Red Rock during the spring

Year	Mallard	Black duck	Gadwall	Wigeon	Pintail	GW teal	BW teal	Shoveler	Wood duck	Redhead	Canvas-back	Lesser scaup	Ring-necked	Golden-eye	Ruddy	Merganser
1970	60.0	0.2	0.5	0.5	20.0	1.0	1.0	1.0	2.0	5.0	5.0	3.0	0	0	0	0.5
1971	20.0	0	0	15.0	15.0	8.0	8.0	5.0	5.0	2.0	1.0	5.0	0	1.0	0	1.0
1972	50.0	0	0	0	20.0	0	0	0	0	1.0	0	10.0	0	0	0	0.5
1973	60.0	0	0	0	10.0	0	0	0	0	3.0	3.0	50.0	0	3.0	0.6	3.0
1974	9.0	0	0	0	3.0	0	0.6	0	0	0.6	0.6	9.5	0.6	0	0	3.0
1975	20.0	0	0	0.5	12.0	0.5	0.6	3.0	0	0.5	0.5	8.0	0	0	0	0.1
1976	10.0	0	0	0	0	0.6	3.0	3.0	0.6	0	0	3.0	0	0	0	0
1977	50.0	0	0	0	0	0	0.6	0.6	0	0	0	3.0	0	0	0	0
1978	12.0	0	0.6	0	0.6	0	3.0	0.6	3.0	0	0	3.0	0	0	0	0

Source: Reference No. 22

> The peak numbers of snow geese are usually higher than the peak numbers of Canada geese. However, Canada geese are usually present at Red Rock for a longer period. The peak number of Canada geese have averaged 2,700 in the spring and 1,350 in the fall from 1969 through 1979. During the same period, snow geese peak numbers have averaged 9,100 in the spring and 3,870 in the fall. There has been an increase in use of the reservoir by snow geese in the spring. Before 1976, peak numbers were not over 8,000. From 1976 through 1978, the peak numbers ranged from 15,000 to 20,000. White-fronted geese were seen at Red Rock during most springs but in small numbers (average peak was 100). The species was recorded during only three falls in the 1970's with less than 100 birds observed at a time.

Waterfowl counts for the Red Rock Lake project, were generally made at one week intervals (Richard Bishop, Wildlife Research Supervisor, pers. comm., 1980), and were used to prepare Table 12 which shows average monthly use of the project by ducks and geese. November was generally the month of maximum waterfowl use of the project, with an 11-year average waterfowl count of just over 36,000 ducks and 2,400 geese. Use of the project by geese in the fall was greater when the lake was new, with less use during this period in latter years.

Waterfowl production has not been quantified at the Red Rock Reservoir project. Two divergent opinions exist on this subject, however, ICWRU investigators reasoned that, since project construction caused a loss of nesting habitat, there was an associated loss of wood duck production, viz:

> The only breeding waterfowl species of importance in the Red Rock area is the wood duck. Although the species still breeds at Red Rock ... production has probably been significantly reduced because of the large loss of floodplain woodland.

An ICC biologist expressed the opinion that brood habitat for wood

Table 12. -- Average counts for ducks and geese at Lake Red Rock for 1970 through 1980; counts made at approximately one week intervals

Year	Months						
	February	March	April	September	October	November	December
1970							
Ducks	2,000	5,800	63,750	-	7,980	34,500	30,500
Geese	50	350	500	-	7,630	12,875	7,400
1971							
Ducks	-	36,930	33,330	3,700	7,940	56,000	16,000
Geese	-	4,680	1,795	150	2,800	6,100	650
1972							
Ducks	-	62,000	-	2,500	5,250	20,000	15,000
Geese	-	4,690	-	50	1,405	2,100	800
1973							
Ducks	-	-	-	4,430	8,750	2,000	-
Geese	-	-	-	130	1,350	250	-
1974							
Ducks	-	-	-	-	-	-	-
Geese	-	-	-	-	-	-	-
1975							
Ducks	-	6,600	20,600	3,950	1,455	20,070	29,250
Geese	-	3,570	6,910	10	540	1,620	1,125
1976							
Ducks	-	-	-	850	-	9,475	-
Geese	-	-	-	40	-	160	-
1977							
Ducks	-	-	-	-	3,950	83,500	200
Geese	-	-	-	-	460	65	140
1978							
Ducks	-	-	-	9,500	6,070	71,000	300
Geese	-	-	-	50	280	350	300
1979							
Ducks	-	-	-	-	3,165	36,600	43,250
Geese	-	-	-	-	825	280	20
1980							
Ducks	-	-	-	1,300	4,700	27,200	15,050
Geese	-	-	-	50	225	525	140
Average							
Ducks	-	-	-	3,750	5,475	36,035	18,695
Geese	-	-	-	70	1,725	2,430	1,320

Source: Richard A. Bishop, ICC, Wildlife Research Supervisor, pers. comm., 1980

ducks was enhanced by creation of the reservoir and that production of this species was increased as a result (Richard Bishop, Wildlife Research Supervisor, pers. comm., 1980), viz:

> ...since impoundment of Red Rock, mallards and blue-winged teal have nested in this area. The major species of breeding waterfowl is the wood duck. Although nesting habitat found in older trees along the floodplain was reduced by flooding, better brood habitat created by the impoundment has increased wood duck production significantly. Wood ducks now use cavities found in trees along the bluffs or up the drainages that come into the floodplain.

Turkey, quail, pheasants and woodcock populations on the Lake Red Rock property were discussed in the ICWRU report. Several key paragraphs from this evaluation are presented below, viz:

> ICC biologists Ronnie George and James Wooley [pers. comm., 1980] believed that the Red Rock floodplain presently receives heavy use by wintering pheasants and, when water conditions permit, nesting pheasants. George and Wooley felt that the reduction of timber and increase in herbaceous habitat in the floodplain benefitted pheasants.
>
> * * * *
>
> Habitat, even if marginal, that did exist in much of the floodplain probably no longer supports quail except near adjacent upland cover [Ronnie George and James Wooley, ICC biologists, pers. comm., 1980]. Despite the protection habitat now receives on public upland areas, the overall impact of Red Rock Reservoir upon quail has probably been negative.
>
> * * * *
>
> ...large amounts of [woodcock] nesting and brood habitat were lost when the floodplain woodlands were reduced [Terry Little, ICC biologist, pers. comm. 1980]. However, the species gained migration habitat in willows and early riparian areas. While local populations may have suffered somewhat, woodcock breeding densities are low in Iowa and the impact on woodcock populations would have been negligible. An increase in migration

habitat would be of little importance to the small migrating population.

Nineteen turkey were first stocked on project lands in 1981 in an attempt to re-establish turkeys. Turkey have been absent from the area for many years (Chuck Kakac, Wildlife Biologist, pers. comm. 1981).

The 1980 ICWRU report stated that eagles are usually observed wintering at the project. As many as 30 have been sighted but more commonly the number is 3 to 5 birds. Red-tailed hawks are known to nest in large numbers at Red Rock. American kestrel, great horned owl, screech owl and barred owl were listed as probable nesters. The largest summer population of turkey vultures in Iowa is reported to reside at Red Rock with up to 160 birds using three roost sites. Great blue herons also nest at Red Rock although apparently with limited success due to pesticide contamination. Larger numbers of great blue herons and some American egrets use Lake Red Rock in the late summer and early fall.

The ICWRU report indicated that 256 bird species have been observed in the Red Rock area within the last 10 years. Table 13 contains a partial list of birds known to reside at, or visit Lake Red Rock. Furthermore, the report indicates that Christmas bird counts at the project have revealed no major changes in wintering bird populations from 1970 through 1979.

Although a large area is permanently flooded by Lake Red Rock, an additional habitat occasionally inundated in the flood pool, changes from

Table 13. -- Partial list of bird species that use Lake Red Rock project

Permanent residents		Occasionally observed	
Marsh hawk	Circus cyaneus	Western grebe	Aechmophorous occidentalis
Red-tailed hawk	Buteo jamaicensis	White pelican	Pelecanus erythrorhynchos
Bobwhite	Colinus virginianus	Great blue heron	Ardea herodias
Ring-necked pheasant	Phasianus colchicus	Double-crested cormorant	Phalacrocorax auritus
Mourning dove	Zenaidura macroura	Great egret	Casmerodius albus egretta
Rock dove	Columba livia	Black-crowned night heron	Nycticorax nycticorax hoactli
Screech owl	Otus asio	Least bittern	Ixobrychus e. exilis
Great horned owl	Bubo virginianus	American bittern	Botaurus lentiginosus
Barred owl	Strix varia	Wood duck	Aix sponsa
Belted kingfisher	Megaceryle alcyon	Canvasback	Aythya valisineria
Common flicker	Colaptes auratus	Sharp-shinned hawk	Accipiter striatus velox
Red-bellied woodpecker	Centurus carolinus	Cooper's hawk	Accipiter cooperii
Red-headed woodpecker	Melanerpes erythrocephalus	Swainson's hawk	Buteo swainsoni
Hairy woodpecker	Dendrocopos villosus	Marsh hawk	Circus cyaneus hudsonius
Downy woodpecker	Dendrocopos pubescens	Osprey	Pandion haliaetus carolinensis
Horned lark	Eremophila alpestris	Merlin	Falco columbarius
Blue jay	Cyanocitta cristata	American kestrel	Falco sparverius
Common crow	Corvus brachyrhynchos	King rail	Rallus e. elegans
Black-capped chickadee	Parus atricapillus	Piping plover	Charadrius melodus
Tufted titmouse	Parus bicolor	Upland plover	Bartramia longicauda
White-breasted nuthatch	Sitta carolinensis	Common tern	Sterna h. hirundo
Robin	Turdus migratorius	Least tern	Sterna albifrons
E. bluebird	Sialia sialis	Black tern	Chlidonias nigra surinamensis
Cedar waxwing	Bombycilla cedrorum	Yellow-billed cuckoo	Coccyzus a. americanus
Starling	Sturnus vulgaris	Short-eared owl	Asio f. flammeus
House sparrow	Passer domesticus	Ruby-thr. hummingbird	Archilochus colubris
E. meadowlard	Sturnella magna	Belted kingfisher	Megaceryle a. alcyon
W. meadowlard	Sturnella neglecta	Red-headed woodpecker	Melanerpes e. erythrocephalus
Common grackle	Quiscalus quiscula	Hairy woodpecker	Dendrocopus villosus
Cardinal	Richmondena cardinalis	Eastern Phoebe	Sayornis phoebe
American goldfinch	Spinus tristis	Purple martin	Progne subis subis
Rufous-sided towhee	Pipilo erythrophthalmus	Brown creeper	Certhia familiaris
		Bewick's wren	Thryomanes bewickii
		Loggerhead shrike	Lanius ludovicianus
		Bell's vireo	Vireo b. bellii
		Warbling vireo	Vireo g. gilvus
		Yellow warbler	Dendroica petechia
		Yellow-breasted chat	Icteria v. virens
		Yellow-headed blackbird	Xanthocephalus xanthocephalus
		Dickcissel	Spiza americana
		Grasshopper sparrow	Ammodramus savannarum
		Vesper sparrow	Pooecetes g. gramineus
		Chipping sparrow	Spizella p. passerina

Source: Reference 1

private to public ownership and the associated vegetative changes have largely offset these losses with respect to the local deer population. According to the ICWRU report, ICC research biologist Lee Gladfelter (pers. comm., 1980) estimated the fall deer population at approximately 280 head. The same source suggested that the pre-project herd probably numbered about 300 animals.

Deer inhabit the brushy bottomland vegetation which has developed within the flood storage zone. In years without prolonged flood storage, the project provides escape cover, and thus improved local habitat conditions for deer (Charles Kakac, Dick Bishop, ICC Wildlife Biologists, pers. comm., 1981).

Judgements provided by local biologists indicate that squirrel and rabbit populations were adversely impacted by Red Rock while furbearers overall may have benefitted, viz:

> Squirrels probably suffered among the highest population losses due to the formation of the reservoir. Squirrels would have benefitted slightly from the protection upland forests received, but "this will hardly be compensating for the major loss of floodplain forest" [Terry Little, ICC biologist, pers. comm., 1980]. Based on the assumption of fall populations at 1 squirrel per 0.4 ha (1 ac) of woodland, [op. cit] squirrel populations have dropped by 45 percent from an estimated 9,900 to 5,400 with the formation of the reservoir.
>
> Decreases in cropland, upland open canopy woodland, floodplain woodland, and upland early sere vegetation [Table 3], plus the decrease in habitat edge [Table 6], would have been detrimental to cottontail populations [Ronnie George and James Wooley, ICC biologists, pers. comm., 1980]. Rabbits still make use of the herbaceous floodplain vegetation now on the reservoir, but not as much as pheasants might [op. cit]. The overall impact

of the reservoir on rabbit populations has been negative, but has not been as drastic as with squirrel populations.

The effects of the reservoir on raccoon populations is debatable. The loss of floodplain woodlands undoubtedly had a negative impact [James Kienzler, Charles Kakac, Ronald Andrews, ICC biologists, pers. comm., 1980]. However, trapping success appears high at Red Rock and the limited access at the reservoir may have benefitted raccoon populations [Charles Kakac and Ronald Andrews].

ICC biologists also felt that the reservoir has had a positive effect on most aquatic and terrestrial furbearers [op. cit]. The increased water area helped aquatic furbearers, while limited access and protection of the uplands helped other species. These speculations are supported by the trapping success at Red Rock. Of special interest are the reportes sightings of possible bobcat tracks at Red Rock [22]. This species is one of the rarest carnivores in Iowa.

Wildlife-related use

A survey of the wildlife-related use of Red Rock project lands and waters was undertaken by the ICWRU between mid-September, 1979 and mid-February, 1980. The procedures used during the survey are presented below just as described in the 1980 ICWRU report, viz:

> Recreational use of Red Rock Reservoir was evaluated from September 18, 1979, through February 13, 1980, by interviewing on site. With the exception of a boat ramp in Elk Rock State Park, all of the area covered was in the Iowa Conservation Commission's (ICC) Wildlife Management Area (WMA) west of the Iowa Highway 14 bridge. This area comprised 52% of the publicly owned lands associated with the reservoir. Roads throughout the WMA were driven several times weekly in order to contact reservoir users. Discussions with ICC biologists helped to determine specific access points on the reservoir. These locations were numbered and, using a table of random numbers, the starting point for each day's rounds was chosen. The direction from the starting point was decided by flipping a coin. During the fall, two investigators worked, usually independently, with one interviewing the early part of the day and the second working in the latter part of the day. Both

started at the same access point and went the same direction each day. This procedure was changed during the opening days of the waterfowl seasons when access points heavily used by waterfowl hunters were concentrated upon, and the opening days of the pheasant and first shotgun deer seasons when the two investigators worked simultaneoulsy but in different sections of the reservoir. During winter, only one investigator interviewed.

The number of vehicles encountered was recorded and, when possible, the occupants interviewed. Recreationists without vehicles were also interviewed. Unless 10 or more people were involved, only 1 person per party was interviewed. The interviewee was offered the choice of a long or short form of the recreation survey. The short form contained the most important questions of the long form. The investigator asked the questions, notably those dealing with opinions. The interviewee filled out those questions. Individuals contacted previously ("repeats") were only asked the questions pertaining to the current visit to Red Rock.

* * * *

The ICC conducted waterfowl hunters' bag checks at Red Rock during the September, 1979 duck season. By comparing the ICC's estimated number of hunter visits to the number of hunters we interviewed in the same time period, a correction factor was calculated in order to estimate the number of hunter visits from our recreation survey data. These estimates were used to evaluate the hunter use predicted during the planning of the reservoir.

A total of 628 parties (about 30 percent of recreationists) were interviewed during the five-month ICWRU survey at the Red Rock WMA. The data show that 86 percent of the parties were comprised of three or fewer members with two the most common (44.5 percent). Des Moines residents comprised the largest user group (43.2 percent) while 26.2 percent resided within 12.9 km (8 mi) of the project and 23.2 percent lived within 80.4 km (50 mi), excluding Des Moines. Thus, approximately 93 percent of the Red Rock WMA users lived within a 80.4 km

(50 mi) radius of the lake. Just over 91 percent of the users were men, with blue collar workers the dominant occupational class.

An estimated 85-90 percent of the waterfowl hunting and about 90 percent of the upland and big game hunting associated with the project occurs on the WMA (Chuck Kakac, ICC Wildlife Biologist, pers. comm., 1981).

The ICWRU survey revealed that 62.6 percent of the persons interviewed were engaged in hunting when contacted (Table 14). Hunting effort over the five month period at the Red Rock WMA was estimated at 1,500 hunter-days (equivalent to hunter-visit) for big game, and 3,400 hunter-days for upland game. The ICWRU reported ICC's data (Table 15) from the regular waterfowl season of 2,300 hunter-days. They did not report, however, the early season waterfowl hunting estimate by ICC of 394 hunter-days (Table 16). The ICWRU pointed out that their estimated hunting effort for raccoons may have been low because most raccoon hunting is done after dark, while the survey was basically conducted during the daylight hours.

Use of the area by waterfowl hunters, depends upon the number of migratory birds attracted to Red Rock during the fall hunting season. The low water levels during the 1979 season at Red Rock may have reduced hunting effort for waterfowl (Richard Bishop, ICC Wildlife Biologist, pers. comm., 1980).

Recreational-use data are reported independently by the CE at most projects (23). Their hunter-use data for Red Rock (Table 17) compare

Table 14. -- Activities of respondents at Lake Red Rock at the time of interview. Percentages do not sum to 100.0 because a respondent may have been engaged in more than one activity

Activity	Number	Percent
Hunting	393	62.6
Fishing	78	12.4
Sightseeing	56	8.9
Wood gathering	34	5.4
Camping	24	3.8
Scouting/preparing for hunting	23	3.7
Target practice	22	3.5
Trapping	21	3.3
Dog trials	17	2.7
Horseback riding	13	2.1
Hiking	8	1.3
Training/exercising dog	8	1.3
Other[a]	41	6.5

[a]Included picnicking (5), nature study (3), bicycling (1), photography (3), bird watching (5), boating (5), mushroom hunting (1), motorcycling (3), archery (1), muzzle loader shooting (2), collecting of rocks, sand, cans, or shotgun shells (3), scouting for trapping area (3), rock climbing (2), sunbathing (1), scouting for four-wheel drive trails (1), observing hunters (1)
Source: Reference No. 1

Table 15. -- 1979 waterfowl harvest survey at Red Rock Lake for early season (September 22-26)

	Opening weekend		Weekdays		Total	
	Estimated total ± CI	% of kill ± CI	Estimated total ± CI	% of kill ± CI	Estimated total ± CI	% of kill ± CI
Hunters	338 ± 94		56 ± 135		394 ± 144	
Ducks killed						
Mallard (m)	19 ± 20	5.7 ± 2.2	0	0	19 ± 20	5.1 ± 2.5
Mallard (f)	26 ± 10	7.9 ± 3.4	0	0	26 ± 10	7.1 ± 2.9
Wood duck	40 ± 5	12.0 ± 7.2	9 ± 23	2.2 ± 8.7	49 ± 19	13.2 ± 7.4
BW teal	105 ± 68	31.7 ± 3.4	14 ± 25	33.3 ± 26.0	119 ± 71	31.9 ± 3.7
GW teal	112 ± 108	33.7 ± 10.6	0	0	112 ± 109	30.1 ± 12.8
Wigeon	10 ± 19	2.9 ± 5.6	0	0	10 ± 19	2.6 ± 4.9
Gadwall	2 ± 3	0.5 ± 0.7	0	0	2 ± 3	0.4 ± 0.6
Pintail	12 ± 12	3.6 ± 1.3	18 ± 45	44.5 ± 17.0	30 ± 38	8.1 ± 8.4
Other dabblers	6 ± 3	1.9 ± 0.5	0	0	6 ± 3	1.7 ± 0.5
Scaup	0	0	0	0	0	0
Ring-neck	0	0	0	0	0	0
Redhead	0	0	0	0	0	0
Other divers	0	0	0	0	0	0
Total ducks	332 ± 230		41 ± 91		373 ± 242	
Ducks lost	29 ± 23		27 ± 50		56 ± 46	
Parties checked	68		3		71	

Source: Richard A. Bishop, ICC, Wildlife Research Supervisor, pers. comm., 1980.

Table 16. -- 1979 waterfowl harvest survey at Red Rock Lake for regular season (October 20 - December 3)

	Opening weekend		Other weekends		Weekdays		Total	
	Estimated total±CI	% of kill±CI	Estimated total±CI	% of kill±CI	Estimated total±CI	% of kill±CI	Estimated total±CI	% of kill±CI
Hunters	423±138		771±300		1097±159		2291±505	
Ducks killed								
Mallard (m)	83± 72	15.7±16.3	114±228	56.0±73.4	1383±627	70.8±37.0	1580±671	58.8±27.0
Mallard (f)	27± 22	5.2± 6.0	23± 46	11.2±14.7	335±434	17.2±16.7	385±437	14.3±13.0
Wood duck	5± 6	0.9± 1.4	0	0	0	0	5± 7	0.2± 0.2
BW teal	126±164	23.6±21.6	0	0	0	0	126±164	4.7± 5.8
GW teal	210±264	39.5±33.2	11± 22	5.5±14.7	183±364	9.4±17.1	404±451	15.0±14.7
Wigeon	17± 30	3.2± 6.6	22± 44	10.9±29.4	0	0	39± 53	1.4± 2.1
Gadwall	32± 18	6.0± 2.2	22± 44	10.9±29.4	26± 52	1.3± 2.4	80± 71	3.0± 2.5
Pintail	24± 14	4.[illegible]± 4.0	11± 22	5.5±14.7	26± 52	1.3± 2.4	61± 58	2.3± 2.0
Other dabblers	8± 11	1.5± 1.5	0	0	0	0	8± 11	0.3± 0.4
Scaup	0	0	0	0	0	0	0	0
Ring-neck	0	0	0	0	0	0	0	0
Redhead	0	0	0	0	0	0	0	0
Other divers	0	0	0	0	0	0	0	0
Total ducks	532±342		203±140		1953±760		2688±846	
Ducks lost	27± 22		0		91±140		118±142	
Geese killed								
Canada	10± 20							
Snow	2± 4							
Parties checked	50		24		17		91	

Source: Richard A. Bishop, ICC, Wildlife Research Supervisor, pers. comm., 1980.

Table 17. -- U.S. Army Corps of Engineers estimates reported for hunter-visitations for Lake Red Rock project during 1978-1980

Area of use	Year		
	1978	1979	1980
Unimprove CE-administered lands	16,810	15,605	15,750
ICC's wildlife management area	22,165	20,065	20,615
Total	38,975	35,670	36,365

Source: Reference No. 23

poorly to the ICC/ICWRU figures. For example, the CE data are 2.7 times higher than the ICC/ICWRU's estimates for the WMA alone. If, as mentioned, 85 to 90 percent of the project-associated hunting effort occurs on the WMA, the CE's hunter-use estimate is approximately 4 times greater when the ICWRU's figure is modified to account for 10-15 percent hunter use on lands other than the WMA.

According to the ICWRU report, ducks, pheasants and geese were the most frequently hunted species at the Red Rock WMA (Table 18).

The ICC required trappers at Red Rock to acquire a trapping permit for the trapping seasons 1974-75 through 1977-78. The number of permits issued was 13 in 1974, 10 in 1975, 24 in 1976 and 25 in 1977. According to the ICWRU, trappers appeared to be less successful at Red Rock during these earlier years compared to 1979, viz:

> Trapping success recorded by the ICC during the 1974-75 and 1975-76 seasons appeared rather low. An annual average of 1.2 raccoons, 0.5 muskrats, 0.3 mink, 0.4 fox, 0.2 coyote, 0.1 skunk, and 0.4 opossum per trapper were reported for the 2-year period. During the 1976-77 and 1977-78 seasons, trapping pressure and success increased. An annual average of 1.7 raccoons, 7.5 muskrats, 0.7 mink, 1.5 beavers, 0.1 fox, 0.2 coyote, and 0.6 opossum per trapper were reported for that 2-year period. Our results [Table 19] showed higher trapping success rates for most species. This may reflect an actual increase in trapper success or be due to inherent differences in the two methods of evaluating trapping.

Persons interviewed during the ICWRU study were asked to suggest areas of improvement for the Red Rock WMA. ICWRU's analysis is quoted below and the tabled materials contained in their report are presented herein as Table 20.

Table 18. -- Composition and bag of hunter respondents at Red Rock; numbers in parentheses are percentages of all hunting respondents; percentages do not sum to 100.0 because a respondent may have been hunting more than one species; total bag: number of animals in possession at time of interviews; bag/hr. is by party, not by individual hunters

Species	At time of interview			
	Number of respondents hunting	Total bag	Bag mean	Bag/hr. mean
Ducks	196 (49.9)	494	2.5	0.33
Pheasant	118 (30.0)	32	0.3	0.09
Geese	96 (24.4)	17	0.2	0.04
Quail	62 (15.8)	16	0.3	0.06
Deer	47 (12.0)	3	0.1	0.01
Rabbit[a]	34 (8.6)	6	0.1	--[c]
Squirrel	29 (7.4)	14	0.5	0.14
Coyote	7 (1.8)	0	0.0	--
Foxes	3 (0.8)	1	0.3	--
Raccoon	3 (0.8)	1	0.3	--
Other[b]	1 (0.2)	2	2.0	--

[a]Analysis does not include one party of hunters in February which bagged one rabbit in four hours of hunting.
[b]Included woodcock, snipe, coot, opossum.
[c]Not enough information to calculate bag/hr.
Source: Reference No. 1

Table 19. -- Trapping activity at Lake Red Rock: data relates to a 2-year period previous to interview; number in parentheses are percentages of all trapping respondents; percentages do not sum to 100.0 because respondents usually trapped more than one species

Species trapped	Number respondents trapping	Number animals trapped per respondent
Raccoon	26 (92.8)	16.1
Muskrat	21 (75.0)	74.8
Mink	15 (53.6)	7.5
Beaver	13 (46.4)	9.7
Foxes	13 (46.4)	3.5
Coyote	9 (32.1)	0.3
Skunk	3 (10.7)	2.7
Opossum	1 (3.6)	10.0

Source: Reference No. 1

Table 20. -- Development preferences at the Lake Red Rock Wildlife Management Area; percentages do not sum to 100.0 because respondents often chose more than one option

Option	Number	Percentage
Left essentially in its present state	305	62.1
Better and more access roads and/or parking lots	154	31.4
More camping and picnic areas	77	15.7
More trails for hiking, riding, nature study, etc.	65	13.2
Fewer access roads and parking lots	45	9.2
More water for recreation	39	7.9
More and better boat ramps	11	2.2
Less vegetation, driftwood, and/or dead timber	10	2.0
More habitat plantings and/or cropland	8	1.6
Stock game	5	1.0
More public hunting area	4	0.8
Other	23	4.7
No opinion	16	3.2

Source: Reference No. 1

All first-time interviewees (491 persons) were asked their opinions on future development of the Red Rock WMA. Most essentially liked the present management, although they often added desired improvements. A high number wanted more and better roads within the WMA. There are over 135 miles of roads within the WMA [Chuck Kakac, ICC Wildlife Biologist, pers. comm., 1979]. However, the roads are difficult to maintain because of the highly erosive effects of the reservoir [Rick Trine, ICC Wildlife Technician, pers. comm., 1979]. Many road segments are also blocked off to prevent access by motor vehicles. The recreationists who desired less access usually stated their desire for uncrowded hunting as the reason.

Other relatively common opinions expressed were desires for camping and picnicking areas, recreational trails, and more water. Most of the respondents who desired more water were referring to the level of the reservoir for duck hunting. During much of the 1979 waterfowl season, the lake level was low enough that accessibility to many areas by boat was difficult. Some of the recreationists who desired more water were referring to marsh areas or more water for fishing.

Wildlife Resources -- Discussion of Planning Input

The Red Rock project is located in Iowa's fertile farming country and most of the surrounding lands are under row crop cultivation. Lake Red Rock [at the currently operated conservation pool elevation 222 m (728 ft)] permanently inundated 4,634 ha (11,450 ac) or approximately 47 km^2 (18 mi^2) of land, and also causes occasional, temporary inundation of additional lands within the flood pool. On the other hand, the project created a large, public holding with diverse ground cover of moisture resistant annuals and perennials and upland forest, creating wildlife habitat now unique to this area of Iowa. The size of the public holdings (includes the largest wildlife management area in Iowa) and location [96 km (60 mi) from Des Moines, Iowa] create

a unique opportunity for management and use of wildlife-related resources. These opportunities most likely would not exist in the absence of the project.

As reported by the FWS in 1960 (3), conversion of fertile floodplain lands in the project area to cultivated croplands had eliminated much wildlife habitat in the project area in years prior to project construction. Unfortunately, neither existing habitat conditions nor expected changes were quantitatively described in the pre-project planning reports, other than the obvious loss of land in the permanent pool. The ICWRU's analysis of aerial photographs revealed the types and amounts of habitat extant within the boundaries at the Red Rock project to project-related changes. This type of basic vegetative inventory should be an essential first step in any attempt to design programs to mitigate wildlife losses.

The ICWRU's photo-analysis of the 19,264 ha (47,600 ac) fee area acquired by the CE showed that 43.3 percent was cropland prior to project construction. Creation of the reservoir resulted in a 37 percent reduction in cropland. Losses of floodplain woodland totalled 1,672 ha (4,130 ac). This typifies losses associated with many water development projects.

The state conservation agency's position on land acquisition was purely reactive in nature. No specific lands were requested beyond those planned for flood stroage purposes by the lead agency. Once acquired, the ICC submitted a basic plan for wildlife management.

Mitigation activities at the Red Rock project have been greatly affected by recent changes in CE policies and also by changes in project conditions associated largely with sediment storage. As a result of these unforseen, fundamental changes, actual post-impoundment conditions for wildlife were poorly perceived and accommodated during the pre-construction planning period.

The recent funding "break through" associated with the CE's modification of Condition-five of the standard fish and wildlife license agreement has tremendously improved the wildlife potential associated with the Red Rock project. Replacing terrestrial wildlife habitat lost through inundation requires increasing the carrying capacity of the remaining project lands. This can be done in several ways, including converting privately-owned lands to public ownership. While public acquisition can help replace wildlife resources through changes in land use, it alone seldom, if ever, constitutes an adequate program to fully replace the terrestrial resources destroyed. This is particularly the case when agencies base mitigation on increases in user-days with certain pre-assigned dollars/user day values. In that public ownership permits greater access, and thus higher user-days, is not necessarily a measure of replacing units of habitat or wildlife population levels.

Thus, the opportunity for the ICC, to realize significant new revenues for habitat management purposes, via sharecropping and/or timber harvest agreement on licensed lands constitutes a valuable tool for mitigation programs. This action is particularly significant where large

tracts of farm lands are included under license to the state agency. Currently, 10,337 ha (25,542 ac) of project lands are under license to the ICC, of which 35 percent or 3,602 ha (8,902 ac) are under share-crop agreement with cooperating farmers. Between 1976 and 1980, the average annual income received by the ICC has amounted to $180,376. These monies have been earmarked for wildlife habitat development on the Red Rock project.

Although state funding sources may not have been adequate for habitat development on Red Rock until increased revenues became available in 1977, planning for mitigation was hampered by the piece-meal outgranting of project lands by the CE.

When Red Rock was proposed, the ICC viewed a large lake (essentially the larger the better) at the site as an attractive possibility. The opportunity to diversify wildlife habitat, with emphasis on waterfowl was welcomed by the ICC from the beginning of project plan formulation. While the ICC originally planned to emphasize goose management at Red Rock, including the establishment of a resident flock, the emphasis has shifted to creating habitat attractive to migrating ducks. To accommodate this management objective, the ICC has utilized the revenues generated at Red Rock to create sub-impoundments. In 1981, an extensive dike system was constructed, with installation of a pumping system planned for the near future.

A second major goal of the ICC at Red Rock is to manipulate forested and non-forested uplands to replace the bottomland forest habitat lost

through inundation. Although the extent to which such upland can be manipulated so as to replace bottomland forest habitat is problematical, such action is planned by the ICC at Red Rock. Development of upland habitat has received less emphasis to date. In the long term, the availability of sustained funding should allow implementation of some kind of upland management program.

The upper portion of Lake Red Rock has filled rapidly with silt. The accumulation has reduced conservation pool storage capacity by 30 percent between 1969 and 1979. This lost capacity persuaded the CE, with FWS and ICC concurrence, to raise the conservation pool's operating level from the authorized 221 m (725 ft) to 222 m (728 ft).

The 1 m (3 ft) increase in elevation, permanently inundated an additional 1,012 ha (2,500 ac). Any permanent land treatment and/or capital improvements for wildlife purposes within this 1,012 ha (2,500 ac) area, had they been made prior to 1979, would have been adversely affected by the raise in water levels. No note was taken of the potential silt problem in pre-construction documentation. The decision to raise the conservation pool elevation 1 m (3 ft) did not solve the siltation problem, making it likely that similar adjustments will be made regularly in the future. This will, or could, become a process of periodically and permanently inundating costly wildlife development.

Two creditable recommendations were provided by the FWS early in the project development phase. These were for surplus buildings on CE lands be preserved for use by the ICC in their wildlife management,

activities, and a request for project boundary monumentation.

At best, the pre-construction information relating to habitat conditions along the Des Moines River below the proposed storage project were sketchy. Oxbow habitat adjacent to the river supported some hunting use. The ICC 1960 evaluation noted that this floodplain habitat would be more fully utilized by squirrels, rabbits, pheasants, and quails and provide greater recreational hunting if recurring floods were controlled. However, the study of aerial photographs failed to reflect quantifiable habitat alteration for a distance of 52.3 km (32.5 mi) below the dam since much of the bottomland forest had been cleared for agriculture prior to construction.

As sub-impoundments are created, and upland agricultural and pasture areas revert or are planted to woodland, the wildlife communities will continue to change. At present, habitat conditions reflect natural vegetative succession as a result of converting privately-owned bottomland and upland to a large public holding surrounding a fluctuating reservoir. Until 1981, financial constraints prevented substantial development of wildlife cover. Natural plant succession, particularly within the lower portion of the flood storage pool, has provided brushy habitat that, when not inundated, provides valuable cover and nesting habitat for many wildlife species. The question is, how long, and to what extent, this bottomland habitat will be available given the siltation rates.

Approximately, 14,815 ha (36,600 ac) of public fee lands are available

for wildlife at the Red Rock Lake project. This is in addition to the 4,452 ha (11,000 ac) normal pool. These areas are similar to the 3,642 ha (9,000 ac) reservoir and 14,147 ha (35,000 ac) perimeter area addressed in the 1960 pre-construction reports. Although the anticipated water and land areas were essentially those provided by the project, most wildlife population projections were associated with project land and water areas without benefit of wildlife management practices.

The singular quantitative population information presented was for the local deer herd. An estimated 25 deer were harvested from the site in 1960, although no mention was made of the herd size from which this harvest was taken. The acquisition of land for the Red Rock Lake project, was expected to provide habitat for one deer per 16 ha (40 ac) or about 964 deer, from which 265 animals might be harvested; an 11-fold increase.

A general qualitative assessment by local big game biologists was that currently a good population of white-tailed deer inhabits the brushy bottomlands within the flood pool during years when flooding does not occur. When flood storage is required, deer as well as all wildlife populations are adversely impacted to an unknown extent. On the average, the current size of the deer herd is about the same (280 animals) as before the project.

Loss of agricultural bottomland and pasture has been offset by creating brushy bottomland and upland hardwood habitat and continued agri-

cultural production on the 14,815 ha (36,600 ac) above the conservation pool.

No quantitative data were provided regarding pre-project or post-project conditions for upland game or furbearers. Prior to construction (1960 ICC report), pheasants were present but in low numbers. The ICWRU reported that ICC biologists believed that pheasants have benefitted from the project. Currently, the Red Rock floodplain is heavily used by wintering pheasants and nesting occurs when water conditions permit. Unfortunately no supporting data are available for these informed ICC opinions.

Quail were also resident to the area prior to construction, the 1960 ICC report simply noting that quail were "present." Today, the Red Rock public lands support fewer quail than before construction due to land use changes. Woodcock were not mentioned in the pre-construction documents but current opinion holds that this species was found in the area in such small numbers prior to construction that the impact of the project was probably negligible.

Turkeys were not present when Red Rock was being planned and no mention of past, present or potential use of project lands by turkeys was contained in any pre-construction report. Large tracts of timber in nearby Iowa counties were stocked earlier with turkeys. Turkeys were recently released (1981) on the Red Rock Management Area. The availability of tracts of timber within the Management Area is believed to afford an excellent opportunity to successfully establish this species within

the Red Rock project boundaries.

Reservoir projects nearly always result in the elimination of bottomland hardwood habitat. As a consequence, squirrel populations frequently suffer and the Red Rock project was no exception. However, this was not expected by the ICC in 1960. Their report characterized the local squirrel population as "excellent" and predicted "no change." ICC biologists place the loss of squirrels at approximately 45 percent compared to pre-project levels; from a population of 9,900 to 5,400 animals. This estimate was based upon the acrease of woodlands destroyed by the project. Reforestation of uplands, as planned by the ICC, will recover some portion of the squirrel population but is not expected to result in full recovery.

Rabbits were present in low numbers prior to construction, but no serious loss was predicted. However, informed opinion currently assumes the loss of cropland, other habitats and edge have adversely affected rabbit populations, although not to the extent as the squirrel population.

No data are available to assess the impact of the Red Rock project on doves, which were characterized as "abundant" prior to the project construction.

No projections were provided by either the ICC or the FWS for the furbearer population surrounding the Red Rock project. Raccoons were very abundant before project construction and trapping success on project lands remains high today for this species. Trapping success remains high for other furbearers and current opinion appears to be that

the reservoir benefitted most aquatic and terrestrial furbearers.

Utilization of the project area by waterfowl includes both production (nesting), and migration. Post-impoundment data indicate that improved conditions (for attracting migrating waterfowl) existed almost immediately following impoundment. Duck-use averaged 45 times greater, and goose-use was 18 times greater (1967 vs 1969-1974), although actual long-term use by waterfowl will not be apparent for several years following construction of the sub-impoundment and possible establishment of a resident goose flock by the ICC.

Although incidental nesting by mallards and bluewinged teal occurs, the only significant waterfowl nesting is by local wood ducks. The ICC staff maintained that greater availability of brood habitat resulting from reservoir, with the continued availability of adequate nesting habitat, resulted in a beneficial impact to wood duck production. ICWRU personnel, on the other hand, surmized that the loss of nesting habitat adversely impacted wood duck production. No definitive data are available to fully resolve this question, although the ICWRU report referred to a "probable" loss of production while the ICC statement that production was enhanced, was quite definite.

Regardless of who might be correct -- ICC or ICWRU -- the project has not added (except for possibly some wood ducks) to the continental waterfowl population. In fact, neither Iowa nor the Red Rock Lake project are considered in the FWS's surveyed area for duck breeding populations. From the standpoint of migration habitat, FWS policy

on waterfowl habitat ranks it as sufficient and low in priority relative to prediction programs. Thus, while duck and goose use did increase dramatically, it is not likely that those populations benefitted.

In 1960, the FWS predicted approximately 12,000 hunter-days on project lands for deer, upland game and waterfowl. This estimate was based on conditions to exist in the absence of specific wildlife-related management activities. This was 67 percent more hunting effort than the 7,200 hunter-days actually estimated from field surveys between September 18, 1979 and February 13, 1980.

The deer hunting effort projection of 1,930 hunter-days (corrected to more accurately reflect eventual changes in land acquisition) was quite close to the estimated 1,500 - 1,650 hunter-days estimated during the 1979-1980 survey. However, hunting effort for upland game in 1979-1980 of 3,400 - 3,800 hunter-days was significantly less than the projected 5,200 hunter-days.

The 1979-1980 ICWRU survey estimated that approximately 2,700 hunter-days were expended at Red Rock by waterfowl hunters. This was well below the expected use (1960 FWS report) of 4,500 hunter-days. It must be noted that habitat conditions extant during the waterfowl hunting season greatly influences use of Red Rock project lands by migrating waterfowl, and thereby directly influences the amount of hunting effort received by the project. One year's data is, at best, only indicative of the average of waterfowl hunting effort over a period of several hunting seasons. It so happened, that the 1979 waterfowl

season was characterized by low water and limited wetland habitat in the shallow upper end of Red Rock Lake.

FISHERIES RESULTS AND DISCUSSIONS

Fishery Resources -- Pre-impoundment Predictions

Planning for the Red Rock project began as early as 1938. The first consideration of fishery-related impacts of the Red Rock and Saylorville Reservoir projects on the Des Moines River in combination, appeared on September 25, 1953 (2). This FWS prepared document summarized the anticipated changes if Saylorville Reservoir were constructed 18 km (11 mi) above the city of Des Moines, Iowa and Red Rock Reservoir were constructed 97 km (60 mi) below Des Moines. At this juncture, a 2,226 ha (5,500 ac) conservation pool was planned for Saylorville Reservoir. However, a small 304 ha (750 ac) conservation pool was planned at the Red Rock site. Therefore, the fishery-related discussions relating to the Red Rock project are not germane to the project as actually built.

The next generation of planning reports for the Red Rock project appeared in 1960. The FWS and the ICC prepared separate reports on the project that year. Reservoirs of three different sizes were under consideration by the CE. Both the ICC and FWS reports addressed probable impacts under each of the three possible construction plans. This report has focused almost entirely on the information which dealt with the Red Rock conservation pool at elevation 221 m (725 ft) msl. It was the largest impoundment of the three proposals under consideration at the time, and was essentially the design chosen for implementation.

The ICC report (4) prepared for, and submitted to the FWS, did not provide detailed quantitative data relating to the river or expected reservoir fishery, but did predict that the reservoir would result in a harvest of 360,000 kg (793,000 lbs) of fish annually (Table 21). Surprisingly, the ICC report projected identical angler-use data for all three reservoir options being considered at the time. Although the three reservoir designs under consideration ranged from 304 ha (750 ac) to 3,642 ha (9,000 ac) (at the 221 m elevation), 108,893 anglers were predicted to visit each project annually.

The ICC report described expected conditions for each of the reservoirs. Habitat improvements, management requirements, and an evaluation of the fish population and angling characteristics for each proposed reservoir were discussed.

A detailed fishery discussion in the subject ICC report was presented for a reservoir a^{+} elevation 219.5 m (720 ft). It noted that if the reservoir were constructed at the 221 m (725 ft) elevation, the larger impoundment would simply increase the fish community and angling use compared to the smaller impoundment at 219.5 m, viz:

> III Red Rock: 725 ft. Elevation
>
> This would be similar to 720 feet elevation except the increased area, volume and depth of water would be conducive for a proportionately greater abundance of fish and heavier angler use.

The basic position taken by the ICC with regard to a large new reservoir fishery at the Red Rock site, is presented for the 219.5 m (720 ft) msl elevation project in the following section:

Table 21. -- Fish population (weight) and harvest (weight) for Des Moines River (without project) and for remaining river and reservoir (with project) as predicted for a 3,642 ha (9,000 ac) reservoir in 1960 by the ICC

Location	Standing crop		Harvest	
	lb	kg	lb	kg
Without project				
Des Moines River*				
"Game" fish**	5,900	2,676	11,200	5,080
"Rough" fish	550,000	249,475	66,100	29,982
Total	555,900	252,151	77,300	35,062
With project				
Reservoir				
"Game" fish	2,237,000	1,014,681	761,000	345,182
"Rough" fish	4,217,500	1,872,193	32,000	14,515
Total	6,364,500	2,886,874	793,000	359,697
Remaining river***				
"Game" fish	200,000	90,718	23,720	10,759
"Rough" fish	280,000	127,005	23,040	10,451
Total	480,000	217,723	46,760	21,210
Grand total	6,844,500	3,104,597	839,760	380,907

* Combined for project site and river for 77 km (48 mi) below proposed dam

** Contains an uncorrected error such that harvest value is greater than standing crop

*** 77 km (48 mi) below dam

Source: Reference No. 4

II Red Rock: 720 ft. Elevation

A. Improvement

a. (1) 5,385 acres of conservation pool two feet or deeper will be created capable of supporting lake type fish.

(2) 915 acres two feet depth or less of water will contribute to basic food production and especially to small fish growth.

b. 48 miles of down stream habitat will be greatly benefitted by increased uniform 300 cfs minimum discharge rate and greatly reduced turbidity.

c. Valuable Nursery Pond sites are available between 740 elevation and 760 elevation. Nursery ponds above 740 level and below 760 take line, could be constructed in the impoundment area.

d. Water could be supplied from impoundment for downstream fish cultural practices

B. Management

a. Intensive undesirable species to be controlled by State Conservation Commission to minimize competition with game fish in the impoundment, upstream and downstream areas.

b. Heavy artificial propogation and stocking of warmwater predator species by State Conservation Commission for:

(1) Upstream
(2) Downstream and
(3) Conservation pool or impoundment

C. Evaluation

a. Fish population

(1) Downstream from impoundment. Introduction of desirable species to create a better fishery in the improved stream. This includes such species as walleye,

s.m. bass, white bass, and appropriate pan fishes. Intensive chemical control of undesirable species in this area.

(2) Upstream (following completion of Saylorville) same as above: Downstream from impoundment. Introduction of desirable species to create a better fishery in the improved stream. This includes such species as walleye, s.m. bass, white bass and appropriate pan fishes. Intensive chemical control of undesirable species in this area.

(3) Pool: New warmwater level lake species to be introduced in addition to the existing catfish population, including largemouth bass-walleye-sauger-white bass-crappies-bluegill and bullheads. Intensive undesirable species control efforts to offset natural habitat advantages of rough fish.

b. Angling

(1) Downstream (below dam) -- greatly improved catfish harvest and new species, walleye-small mouth bass and sight feeding pan fish is assured.

(2) Upstream (above impoundment) -- (Following completion of Saylorville), same as above.

(3) Pool: Normally we would anticipate a domination of carp and suckers, followed by pan fish in abundance. If chemical and mechanical controls are successful and turbidity is not a controlling factor, pan fish would dominate the population and that such game species as walleye and large-mouth bass would provide the bulk of the fishing.

The FWS released their report on the project on September 30, 1960 (3). They also evaluated three conservation pool elevations at the

request of the CE. The FWS predicted that a lake with a conservation pool at 221 m (725 ft) of some 3,642 ha (9,000 ac), would attract 72,000 fisherman-days, annually.

The FWS letter report recommended that: (1) the pool be at 221 m, and (2) that project lands and waters be administered by the ICC under provisions of a General Plan. No other mitigation or development recommendations were provided.

A substantiating report was attached to the FWS's 1960 report which contained narrative documentation for the conclusions reached, viz:

> Fish. In addition to the principal species of fish now present in the river (carp, suckers, bullheads, channel catfish and flathead catfish), it is expected that several additional species could be established in the reservoir when the project is in operation. These species are largemouth bass, white bass, walleye, sauger, crappies, bluegills, and bullheads. If the conservation pool is established at elevation 720 or 725, it is anticipated that a significant lake-type fishery for these species will result.
>
> With a regulated low-flow of 300 cfs measured at Ottumwa, it is believed that populations of the above species plus smallmouth bass and certain other pan fishes could be established downstream from the dam.

The fish and wildlife evaluations were prepared in accordance with the procedures established by the Inter-Agency Committee on Water Resources. Using this newly adopted procedure of applying dollar values to anticipated recreation days provided a fishery value of $108,000 annually (72,000 reservoir angler-days x $1.50/angler-day). No commercial fishing was anticipated at Lake Red Rock. The following pertinent observations guided the FWS's planning effort for the project, viz:

> One-fifth of Iowa's population, approximately 547,000 people, live within 50 miles of the Red Rock Reservoir site. There is a critical need for additional public waters for fishing and waterfowl hunting in central, south, and east Iowa. The State-owned lakes in this portion of Iowa receive tremendous use yet meet but a small fraction of the current demand.
>
> Following completion of the Coralville Reservoir, on the Iowa River, 80 miles northeast of the Red Rock site, sales on fishing licenses, boats, fishing tackle and other fishing accessories virtually skyrocketed. Thousands who did little or no fishing before the reservoir was constructed are now serious fishermen.

Additional fishery benefits were predicted, though not quantified, if the ICC managed the fishery resources of the new reservoir, viz:

> If project lands and waters below the fee-taking line are made available for administration by the Iowa Conservation Commission for fish and wildlife management purposes in accordance with a General Plan, substantial additional fish and wildlife benefits will be realized.
>
> The fish management practices would include the control of undesirable species in the reservoir and stocking desirable species, as necessary, in the impoundment and downstream. The Iowa Conservation Commission will construct fish nursery ponds to rear fish for stocking if a suitable location is available.
>
> * * * *
>
> It is our opinion that a fish and wildlife management program along the lines outlined above will result in substantial additional benefits.

The report failed to supply impact projections for post-impoundment conditions which included management by the ICC.

No specific recommendations relating to fisheries resources were suggested by either the ICC or the FWS other than extending strong support for the largest of the three alternative reservoir designs under con-

sideration. Only minimal communications were exchanged following issuance of the formal reports of 1960.

Meetings between FWS and ICC personnel in 1962 and 1963, prompted by the FWS, attempted to establish a course of action leading to acquisition of management authority under a General Plan of those project lands deemed most suitable for fish and wildlife management purposes. As discussed in the wildlife assessment section of this report, the conservation agencies requested an area of 12,141 ha (30,000 ac) located above Highway 14 (Figure 1) during those meetings. Some of this land was expected to provide a fish nursery area.

By December 18, 1963, a CE-developed plan was adopted by all parties whereby 6,880 ha (17,000 ac) of floodplain lands would be made available to the ICC for fish and wildlife management. Additional lands were to be made available to the ICC at a later date. This 6,880 ha area included about 81 ha (200 ac) that were expected to be used by the ICC for fish nursery developments to produce game fish for stocking the reservoir (7).

The CE decided to construct the largest of the three reservoirs under consideration, providing a conservation pool at elevation 221 m (725 ft) msl. The CE's Master Plan for such a project was released in 1967 (24), just under two-years before the lake was completed.

A summary statement reflecting the lead agency's views of the project-associated fisheries resources was contained in the Master Plan and

is presented below, viz:

> Fish. The fishery resource in the project area is typical of Midwest streams with a population dominated by commercial grade fish. Studies by the Iowa Conservation Commission indicate the rough fish/game fish ratio is probably about 8 to 1. The channel catfish is preferred by most fishermen in the project area. The major tributaries provide very little to the fishery resource except, perhaps, spawning areas. The conservation pool will change 1,150 acres of stream environment into a lake environment and this vastly increased volume of water, and related change in habitat, will greatly enhance development of panfish populations. However, only management will prevent the lake waters from being dominated by indigenous rough fish populations.

No further elaboration of significance was contained in this key planning document.

The General Plan was formally signed in the spring of 1962 and the reservoir was impounded in April, 1969.

Fishery Resources -- Post-impoundment Occurrences

Following impoundment of Lake Red Rock in 1969, major changes occurred in the aquatic ecosystem within the impounded zone. Post-impoundment data can be separated into sport and commercial lake fisheries.

Lake Red Rock sport fishery

Impoundment of Lake Red Rock commenced on 18 April, 1969, and as a result of abnormally heavy precipitation, the lake covered 17,807 ha (44,000 ac) by mid-summer. The ICC conducted a stratified, random design creel survey at Lake Red Rock between May 1 and September 17, 1971 (25). The essence of this report, was contained in the following paragraphs:

Red Rock pool

Combined shore and boat effort resulted in harvest of 6,438 fish by 5,334 anglers expending 13,381 hours. Boat anglers exerted 7,260 angler hours by 1,876 individuals. Mean length of completed trip was 3.9 hours with success of 1.6 fish per trip or .4 fish per angler hour. Estimated harvest by boat anglers was 3,011 fish or .3 per acre. Shore anglers spent 1.8 hours per trip but had greater success than boat anglers. These anglers caught .6 fish per hour, expending 6,121 hours and creeling 3,427 fish or .4 fish per acre. Estimated use of the conservation pool by shore anglers was 3,458 individuals taking one fish per trip.

Species composition of the creel was dominated by bullhead and carp comprising 67.5% and 16.7% of the sample, respectively. Largemouth bass, crappie, channel catfish, green sunfish, walleye, white bass, yellow bass, and freshwater drum followed in order of decreasing abundance with 4.1%, 3.4%, 3.4%, 2.7%, 1.0%, .3%, .3%, and .3%. Bullhead was most prevalent in the creel regardless of seasonal period while carp always ranked second except in periods 5 and 6. The only walleye seen by the creel clerk were in periods 1 and 3 while channel catfish became important in the creel in periods 4-9. [i.e: Each period was two weeks long beginning May 1.]

Anglers were grouped by distance travelled into the following categories: 0-5, 6-10, 11-20, 21-50, and 51+ miles. As expected the greatest frequency occurred at 21-50 miles, corresponding to distance from the Des Moines metropolitan area. This category contained 62.8% of the anglers followed by 6-10 miles, 18.3%; 51+ miles, 9.9%; 11-20 miles, 7.1% and 0-5 miles, 1.9%. The 6-10 miles class contained many anglers from Knoxville and Pella. Approximately 80% of all anglers came from Des Moines, Pella, Knoxville, Ottumwa and Oskaloosa.

Red Rock tailwaters

An estimated 43,204 fishermen exerted 149,671 angler hours and removed an estimated 51,528 fish in the tailwaters region of the reservoir. Shore anglers were more numerous than boat anglers comprising 38,780 individuals who caught 46,409 fish after expending 132,240 angler hours. Mean length of completed trip was 3.4 hours with .4 fish per hour or 1.2 fish per trip. The boat:shore angler ratio was approximately 1:9 with

4,424 boat angler trips. Boat anglers expended 17,431 hours and caught 5,119 fish. Mean length of trip was 3.9 hours or approximately one-half hour longer than for shore anglers. Success was .3 fish per hour or 1.2 fish per trip.

Species composition of the catch was dominated by carp with 30.6%. Second most prevalent species creeled was crappie, 17.5%; followed by bullhead, 16.2%; channel catfish, 14.9%; walleye, 9.0%; northern pike, 6.0%; freshwater drum, 2.1%; buffalo, 1.4%; largemouth bass, .8%; bluegill, .7%; yellow perch, .3%; white bass, .2%; flathead catfish, .2%; and carpsucker, gizzard shad and green sunfish each with .1%.

Carp ranked first in periods 1, 5, 6, 8, 9 and 10 while crappie ranked first in period 2 and second in periods 6, 8 and 9. Bullhead were predominant in the anglers catch during periods 1, 2 and 3 when they ranked third, second and first. Walleye were also important in the creel during periods 1-4 when they ranked second, third, fifth and fourth. Northern pike fishing was most successful in periods 1, 5, 8, 9 and 10. General observation indicated northern pike were creeled at a higher rate when discharge rate was increased. Travel characteristics were similar to pool area anglers.

Although the 1971 survey represents the only attempt made by the ICC to quantify angler-use and harvest at Lake Red Rock, informed opinion indicates that there have been relatively few changes in the project-associated recreational fishery since that time (Tom Putnam, Area Fisheries Manager, ICC, pers. comm., 1981). The sport fishery continues to be concentrated in the tailrace and in the Des Moines River above the normal pool. White bass have become more abundant in the recreational harvest since the 1971 survey. This species provides excellent spring angling in the Des Moines River all the way upriver to Des Moines. White bass supplement the lake and tailwater fisheries. Channel catfish migrate upstream from Lake Red Rock into the Des Moines River

AD-A122 725 EVALUATION OF PLANNING FOR FISH AND WILDLIFE AT CORPS OF ENGINEERS RESERVOIRS RED ROCK RESERVOIR PROJECT IOWA (U) SPORT FISHING INST WASHINGTON DC NOV 82 2/2

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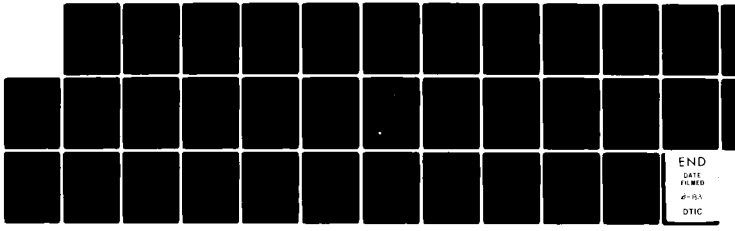

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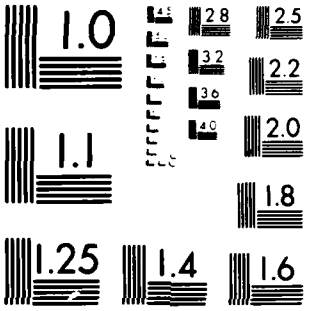

where they support an important sport fishery. Crappie provide occasional good fishing in the lake and the species is more important to the recreational fishery today than when the 1971 survey was conducted.

The lake itself, continues to be lightly used by anglers due to water level fluctuations and the frequently turbid water and floating debris conditions.

As noted in the section of this report covering wildlife matters, the CE independently report use estimates (23). These standardized survey procedures rely heavily on road counters. For the three year period 1978, 1979, and 1980, the CE reported 161,983, 160,633 and 217,921 angler visitations to the Red Rock project, respectively.

A recent (1978), qualitative description of the Lake Red Rock fishery appeared in the CE's Fish and Wildlife Management Plan (26). This description was prepared by the ICC's fisheries manager responsible for Lake Red Rock, and is reproduced below, viz:

> As with many flood control reservoirs, Red Rock Reservoir poses some monumental problems when it is approached from a fish management standpoint. The extent of its watershed, 12,323 square miles at the time of construction, is an assurance that excessive silt loads are frequently carried to and deposited into the reservoir's conservation pool. Extreme water level fluctuations, which can occur especially during and following the spring thaw period, are usually detrimental to the natural reproduction of the gamefish populations.
>
> The settling out of waterborn sediments in prime spawning areas also adds to gamefish reproductive failures.
>
> There have been numerous occasions since the reservoir's impoundment in 1969 when water conditions favored the

harvest of excellent catches of several species including largemouth bass, northern pike, walleye, crappie, and channel catfish. Angling is especially good for those species during May-June and September-October if the reservoir is near the conservation pool level. Water clarity of at least 1 foot depth is also important for best fishing.

Of the before mentioned species, all but crappie and channel catfish, have been previously stocked in large numbers to provide adequate harvestable populations. Crappie and channel catfish are capable of sustaining themselves naturally. Largemouth bass also successfully reproduce when the spring water conditions are favorable.

* * * *

Fish management surveys during the past two years (1976 & 1977) have documented an excellent channel catfish population, especially at the northern reaches of the reservoir, a very good population of crappie and an adequate population of largemouth bass. Northern pike and walleye, due to lack of natural reproduction, are on the decline and their populations need to be bolstered through a maintenance stocking program. Further stocking had not been advisable again until this year (1978), however, because low water conditions the past several years were conducive to poor fry survival.

* * * *

Stockings, within the next three years, will not only improve angling in the lake for these species but below the dam as well. A good tailrace fishery is dependent upon gamefish filtering through the outlet structure and congregating below it.

There are several areas on Red Rock that periodically offer good fishing. These include the upper end of the lake on the Des Moines River, the upper reaches of Whitebreast Creek, the outlet below Roberts Creek Lake and the face of the dam. The old Des Moines River channel is also a choice angling area in Lake Red Rock.

* * * *

It should be noted that white bass represent an increasingly important game fish at Lake Red Rock... Their

reproductive capabilities, as shown by their growing numbers, will continue to add to the fishing diversity.

The CE has developed many fishing facilities in the Lake Red Rock tailwater. These features were adequately described in the CE's Resource Master Plan (27), viz:

> Existing development in the tailwaters is located in three areas along the river. The first, -- is directly below the dam on the north and south sides of the river. This site is currently used as a visitor observation area and for access to the riverbank by fishermen. The area lacks vehicular control, designated parking and adequate buffer space adjacent to the river.
>
> * * * *
>
> Initial development [at the first area] consists of a paved road and parking area, viewing areas, trail access to the bank fishing area, two fishing piers for the handicapped, two picnic shelters, and 20 picnic units. Support facilities include a fish-cleaning station, water distribution, parking lot lightings, plantings, and designated parking lots.
>
> [The second site] is located approximately one-half mile south of the dam, and consists of uncontrolled camping and fishing area. Campers and fishermen park wherever there is a space, creating a maze of vehicles and a combination of activities. Two vault toilets serve the large number of visitors who frequent the area. A one-lane boat ramp provides access to the river, but contains no parking area. A double vault toilet serves the boat ramp facility.
>
> * * * *
>
> The third area scheduled for development in the tailwaters is an existing camping site, locally known as Ivan's. The site is located directly off county road P, adjacent to the west bank of the Des Moines River. The existing facilities include 22 "no fee" camping units, a water supply and two vault toilets.

In 1977, the ICC published a detailed report which described develop-

ment of the lake fishery. The report was based on results of test-netting by ICC biologists and compared the fishery of frequently fluctuating Lake Red Rock to the fishery of more stable Rathbun Lake, Iowa (28). Relative abundance, species composition, size distribution, age structure, reproductive success and stocking success for the period 1972-1975 were all discussed in this document. The study reported that domestic and industrial waste largely determined the nutrient levels and dissolved oxygen concentrations at the lake. The lake was reported to be weakly stratified during summer months. Chronic turbidity was said to be due to prevailing wave action on silt laden substrates. Phytoplankton populations were reported to be limited by hydraulic retention, turbidity, and weather. The macrobenthos community was described as less abundant at Lake Red Rock than at other rservoirs, and the species diversity to be relatively low, comprised primarily of oligochaetes, chironomids, and Chaoborus punctipennis.

Lake Red Rock supported a large population of carp immediately after impoundment. A study of the fish community in Lake Red Rock documented that carp, river carpsucker, and bigmouth buffalo comprised 83 percent of the numerical catch in pound nets. As a result of these findings, a commercial fishery was opened in 1973. This fishery will be discussed in a later section of this report.

Continuing netting studies reflected fish community trends over the period 1972-1975 (Table 22). River carpsucker appeared to increase slightly in relative proportion in these catches, while the other major

Table 22. -- Species composition by percent of the catch in both numbers and weight in pound and experimental gill nets, Lake Red Rock, 1972-1975

Species	Percent of catch by number				Percent of catch by weight			
	1972	1973	1974	1975	1972	1973	1974	1975
Gizzard shad	5.5	.6	8.2	4.2	2.8	.1	3.5	.8
Northern pike	.2	1.4	1.6	1.3	1.6	1.7	5.9	6.4
River carpsucker	17.2	17.0	18.5	25.9	17.9	22.3	22.0	32.7
Bigmouth buffalo	8.1	2.1	3.9	3.9	22.1	6.5	10.1	5.9
White sucker	< .1	< .1	< .1	< .1	< .1	< .1	< .1	< .1
Carp	30.2	30.9	24.5	21.9	37.6	47.8	31.4	21.1
Bullhead	18.4	21.6	8.9	11.4	6.5	8.5	4.7	4.7
Channel catfish	1.6	1.0	.7	.9	2.6	1.2	.8	.9
Flathead catfish	.1	< .1	< .1	< .1	.1	< .1	.1	< .1
White bass	.3	1.5	5.7	3.3	.2	.4	1.9	2.9
Yellow bass	< .1		< .1	< .1	< .1		< .1	.1
Striped bass[a]	---	---	---	---	---	---	---	---
Crappie	12.5	13.3	21.4	20.2	5.8	6.2	14.1	18.4
Bluegill	.8	1.1	1.3	.8	.2	.3	.3	.4
Green sunfish	.1	1.2	.2	.1	< .1	.3	< .1	< .1
Largemouth bass	.4	1.8	1.9	1.4	.5	2.1	3.1	2.6
Walleye	.2	1.5	1.3	1.4	.8	.4	1.2	1.9
Freshwater drum	3.9	3.6	.8	1.4	1.0	1.3	.2	.7
Others[b]	.5	1.1	.8	< .1	.6	1.0	.7	< .1
Total catch in number and kilograms (pounds)	10,102	8,917	11,954	8,565	2,659 (5,862)	2,863 (6,312)	4,075 (8,984)	2,826 (6,230)

[a]All fish caught were 0-age striped bass.
[b]Others include northern redhorse, goldfish, Notropis (spp), spotted gar, yellow perch and redear sunfish.
Source: References No. 28

non-game species (carp and bigmouth buffalo) decline slightly. Statistical analysis of the relative catch success per net day (Table 23), reflected no significant change, however. White bass increased in the catch at Lake Red Rock.

Stocking of game fish began in 1969. Since then Lake Red Rock has been stocked with 8.95 million northern pike, 74.7 million walleye, and 1.2 million largemouth bass (Table 24).

Seine sampling for young-of-year reflected generally poor reproductive success for northern pike, and walleye. Largemouth bass young were captured in significant quantities in most years but were only poorly represented in the 1975 seine samples (Table 25). Total seine catch among years did not vary significantly, but annual catches varied within some species. 0-age channel catfish, carpsucker and carp were more abundant in 1972 that any other year. Young gizzard shad was more numerous in 1972 and 1974. Young northern pike were only captured in 1973 and young bullhead catfish and largemouth bass were captured in significantly greater numbers that year.

Data contained in the 1977 ICC report attempted to correlate reservoir operational conditions with the fish sampling data (28). This important discussion is presented in its entirety in the following section, viz:

IMPACT OF RESERVOIR OPERATIONS ON CATCH SUCCESS

> Variation in annual catch success of fish at Lake Red Rock was related to storage volume, lower catches were associated with higher storage. Other regimen did not

Table 23. -- Catch success (fish per net day) by pound net, experimental gill net and combined catch at Lake Red Rock, 1972-1975

Species	Pound net				Experimental gill net				Combined catch			
	1972	1973	1974	1975	1972	1973	1974	1975	1972	1973	1974	1975
Carp	39.7	34.1	54.4	32.8	13.5	4.9	7.3	7.8	53.2	39.0	63.7	40.6
Crappie[a]	15.6	13.8	47.9	31.2	8.7	5.6	4.9	3.4	24.3	19.4	52.8	34.5
Bullhead	22.3	21.0	17.9	13.0	15.4	14.3	10.1	20.0	37.7	35.3	27.9	33.0
Bigmouth buffalo	11.3	2.7	8.8	6.0	.7	.4	.9	.7	12.0	3.0	9.7	6.7
River carpsucker	22.9	18.3	40.2	40.2	5.3	4.5	9.1	3.5	29.1	22.8	49.2	43.7
Channel catfish	1.4	.9	1.1	.6	3.4	1.1	2.1	3.7	4.8	2.0	3.2	4.3
Gizzard shad	3.1	.2	12.7	2.3	18.7	2.0	22.6	17.2	21.8	2.1	35.3	19.5
Freshwater drum	3.3	2.5	1.3	1.5	9.2	6.2	2.0	3.3	12.4	8.7	3.3	4.7
Walleye	.2	.1	1.3	1.0	.2	6.2	6.4	4.8	.4	6.3	7.7	5.8
Bluegill	1.1	1.3	3.1	1.3	< .1	.2	.1		1.1	1.4	3.2	1.3
Green sunfish	< .1	.9	.4	< .1	.5	1.9	.3	.4	.5	2.7	.7	.5
Northern pike	.2	.6	2.4	2.0	.3	3.9	4.7	.8	.4	4.5	7.1	2.7
Largemouth bass	.4	1.4	3.5	2.2	.6	2.3	3.0	.5	.9	3.7	6.5	2.7
Goldfish	.1	.6	1.5		< .1	.4			.1	1.0	1.5	
Flathead catfish	.1	< .1	.1	< .1	.1	.1	.1		.1	.1	.1	< .1
Northern redhorse	.2	< .1	.2	< .1	.3	.1	.1		.5	.1	.2	< .1
White and yellow bass[b]	.4	1.4	8.0	5.9	.2	1.1	19.4	5.0	.6	2.5	27.4	10.9
Spotted gar	< .1	.2	.1		.7	.2	.1		.7	.4	.2	
Notropis (spp)	< .1	< .1			.2	.4	.2		.2	.4	.2	
Redear sunfish	< .1	.1	< .1		< .1	< .1			< .1	.1	< .1	
White sucker	< .1	< .1			< .1	.1			< .1	.1		
Yellow perch	< .1	< .1	< .1		< .1	.1			< .1	.1	< .1	
Total	122.3	100.1	205.1	140.0	78.7	55.6	93.4	71.1	201.0	155.6	298.5	211.1

[a]Primarily black crappie.
[b]Primarily white bass.
Source: Reference No. 28

Table 24. -- Chronological order, number and stage of fish stocked in Lake Red Rock

Year	Species	Number	Stage
1969	Northern pike	1,050,000	Larvae
	Walleye	21,780,000	Larvae
	Largemouth bass	132,000	Postlarvae
	Largemouth bass	570,000	Larvae
1970	Northern pike	400,000	Larvae
	Northern pike	400,000	Postlarvae
	Walleye	8,000,000	Prolarvae
	Walleye	200,000	Postlarvae
1971	Largemouth bass	335,000	Larvae
1972	Northern pike	600,000	Larvae
	Northern pike	1,000,000	Postlarvae
1973	Largemouth bass	133,500	Larvae
	Largemouth bass	30,000	Postlarvae
	Northern pike	2,250,000	Larvae
	Walleye	7,000,000	Larvae
1976	Walleye	2,500,000	Postlarvae
1978	Northern pike	500,000	Larvae
	Walleye	9,000,000	Postlarvae
1979	Northern pike	750,000	Postlarvae
	Walleye	12,200,000	Postlarvae
1980	Northern pike	1,000,000	Postlarvae
	Walleye	9,000,000	Postlarvae
1981	Northern pike	1,000,000	Postlarvae
	Walleye	5,000,000	Postlarvae

Source: Tom Putnam, Fisheries Manager, ICC, pers. comm., 1981

Table 25. -- Species composition and catch of 0-age fish and Notropis (spp) by seine sample in Lake Red Rock, 1972-1975

Species	Year			
	1972	1973	1974	1975
Gizzard shad	6,227	953	8,520	805
Northern pike		15		
River carpsucker	696	6	73	131
Bigmouth buffalo	7	64	442	9
Notropis (spp)	4,004	1,284	477	153
Carp	210	18	83	29
Channel catfish	81	8	12	26
Bullhead[a]	5	6,988	6	1
White bass	114	203	772	73
Yellow bass				
Striped bass	---	---	---	---
Crappie[b]	217	135	1,493	198
Bluegill	31	79	8	18
Green sunfish	3	6	1	2
Largemouth bass	113	595	354	19
Walleye	8	20		13
Freshwater drum	91	8	51	153
Others[c]	3	11	1	3
Total number	8,954	10,391	12,379	1,633

[a]Primarily black bullhead.
[b]Black and white crappie.
[c]Includes white sucker, goldfish, flathead catfish, smallmouth bass, yellow perch, and logperch.
Source: Reference No. 28

appear related. A similar comparison to water management data from Lake Rathbun did not show the same phenomena. Subjective rank in order of increased floodwater storage in Lake Red Rock, was 1972, 1975, 1974 and 1973. Catch success of major fish species at Lake Red Rock were then compared to the subjective rankings by linear regression.

Considerable difference in coefficient of determination values were derived but one paramount fact was evident in that nearly all species at Lake Red Rock were caught at the lowest rate in 1973, the year of highest reservoir volume except stocked sport species and bullhead. Channel catfish, bigmouth buffalo, bullhead and gizzard shad had negative relationships. Stocked sport fish including northern pike, walleye, and largemouth bass had positive relationships.

Regression equations did not result in significant predictable equations except for channel catfish. A dilution affect appeared but it was not of significant magnitude, apparently other factors played a more important role. Positive R^2 values of stocked species were created by recruitment of large plantings of 0-age fish in previous years and was not indicative of reservoir volume. Recruitment of strong year classes was responsible for reduced R^2 values of many fish, particularly crappie, river carpsucker and carp during high reservoir volume. Strong 1972 year classes of river carpsucker and carp were fully vulnerable to net gear by 1974 while some members of the 1974 year class of bigmouth buffalo, a faster growing fish, were caught by nets that same year. Thus, catch success was higher in 1974, a year that had a higher ranking of reservoir volume than 1972 or 1975. A strong 1971 year class of crappie, not documented in seine hauls, is responsible for the high catch of crappie in 1974. Statistical analysis of reservoir operations on the abundance of 0-age fish did not result in any conclusive findings; however, some generalizations are apparent. Strong year classes of bluegill, crappie and largemouth bass were recorded at Lake Rathbun in 1973, a year of high reservoir elevation, as were largemouth bass and bullhead at Lake Red Rock. Another high water year at Lake Red Rock, 1974, was very good for white bass, crappie, and bigmouth buffalo.

Near normal pool elevations of Lake Red Rock during 1972 appeared to be conducive for carp, river carpsucker and channel catfish reproduction since catches

> of 0-age fish of these species were significantly higher that year.

Evidence indicated that the number of young-of-year of several game fish species was directly related to the ICC's stocking program, viz:

> Fish stocking at Lake Red Rock and Lake Rathbun did not change the species composition significantly in either reservoir but served to establish or maintain most populations. However, the dramatic increase in relative abundance of walleye, northern pike, and largemouth bass at Lake Red Rock was due to plantings. An extremely low catch of these species was recorded in 1972, but in the years following marked increases in catch success was due to complete recruitment of these fish and their progeny. Seine catches of walleye, northern pike and largemouth bass were numerically higher in 1973, a stocking year for all three species. Largemouth bass catches were significantly higher and [1973] was the only year 0-age northern pike were taken in seine hauls. Although, northern pike were stocked in 1972, most were fingerlings, larger than fish planted in other years.

Calculations indicated that growth of the predators largemouth bass, black crappie and walleye was usually greatest in the first year of impoundment or the first year of stocking. Growth of northern pike was decidedly contrary to the rule, as the first stocking year, 1969, was the poorest growth season recorded.

The ICC report (op. cit), proposed a 3.3 m (10 ft) increase in the reservoir pool elevation. The discussion contains some interesting items and is reproduced below, viz:

> A water level increase of 3.3 m (10 ft) at Lake Red Rock would greatly enhance production of fish populations. An Environmental Impact Statement was prepared for the U.S. Army Crops of Engineers in August of 1975 (Anonymous, 1976b). The document presented an assessment of the operation and maintenance of Red Rock Dam and Lake Red Rock. Basically, some of the adverse

environmental impacts included; periodic inundation of terrestrial habitat between conservation pool and flood pool; an estimate of 5.4 million CM (4,400 ac ft) of sediment deposition in the upper reaches of the lake; and resultant unstable aquatic environment. Nine alternatives to the present operational procedures were offered, which included; raising conservation pool by 1 m (3 ft), 1.6 m (5 ft), 2.2 m (7 ft), and 3.3 m (10 ft). From a fishery resource standpoint an increase in conservation pool elevation of 3.3 m (10 ft) would be the best alternative. Chronic siltation will always be a problem at this reservoir until stringent land management regulations are administered, but an increase in reservoir elevation would permanently inundate more habitat, increase the lake surface area and volume, particularly upstream from the main pool area. Thus, deposition of silt would be confined more to the upper reaches, resulting in a less turbid main pool. Reduced turbidity would enhance primary production and higher production at other trophic levels. Greater reservoir volume would reduce flushing rate and increase survival of larval fish. In addition an increase in littoral habitat would be beneficial to the development of Centrarchid populations.

A 1 m (3 ft) increase was later adopted by the operating agency.

Lake Red Rock commercial fishery

As noted previously, commercial fishing was authorized at Lake Red Rock in October, 1973. Fishing gear is restricted to trammel or gill nets at least 30 m (100 ft) long and having a 7.5 cm (3 in) or larger mesh size. Catch is reported each year by ICC biologists. Pertinent data from these reports for the years 1974 through 1979 were provided by the ICC (James Mayhew, Superintendent of Fisheries, ICC, pers. comm., 1981).

The annual commercial harvest figures for Lake Red Rock for the period 1974-1979 are presented in Table 26. Harvest declined following removal of the large standing crop of adult fish available when the com-

Table 26. -- Commercial fish harvest in kilograms (pounds) at Lake Red Rock, Iowa for period 1974-1979

Species	Year 1974 kg	(lbs)	1975 kg	(lbs)	1976 kg	(lbs)	1977 kg	(lbs)	1978 kg	(lbs)	1979 kg	(lbs)	Average kg	(lbs)
Bigmouth buffalo	386,636	(851,623)	442,029	(973,630)	268,240	(591,367)	154,925	(341,551)	166,815	(367,765)	182,898	(403,220)	266,800	(588,193)
River carpsucker	0	0	361	(795)	7,287	(16,065)	7,057	(15,558)	3,493	(7,701)	3,629	(8,000)	3,638	(8,020)
Carp	53,209	(117,201)	27,484	(60,538)	17,287	(38,111)	10,972	(24,189)	8,851	(19,514)	56,191	(123,879)	28,987	(63,905)
Drum	5,213	(11,484)	3,405	(7,502)	1,045	(2,304)	2,267	(4,998)	1,747	(3,852)	2,508	(5,530)	2,697	(5,945)
Total	445,059	(980,308)	473,279	(1,042,465)	293,858	(647,847)	175,221	(386,296)	180,907	(398,832)	245,225	(540,629)	302,122	(666,063)

Source: James Mayhew, Superintendent of Fisheries, IOC, pers. comm., 1981

mercial fishery program first began in late 1974 and in 1975. Recently, the catch of buffalo and carp has increased, but to lower levels than the first two years of fishing. Bigmouth buffalo dominated the fishery, comprising on the average, about 88 percent of the total catch.

Table 27 reflects the commercial harvest on a surface area basis. The table shows an average commercial harvest of 83.4 kg/ha (74.4 lbs/ac) over the six year period of record (1974-1979) with a peak harvest of 130.7 kg/ha (116.4 lbs/ac) in 1975 (the first full year of commercial fishing). Estimated total values of the commercial harvests ranged from just under $200,000 in 1975 to approximately $84,000 in 1978. The average value was approximately $101,000 (Table 28).

The 1977 ICC report (28), noted the effect which the commercial fishery had on the size structure of the commercial species, viz:

> The selective nature of the commercial fishery tended to reduce the mean size of the valuable species in net gear. For example, early in this study the mean weight of bigmouth buffalo increased from .71 kg (1.56 lbs) to .87 kg (1.92 lbs), 1972-74. Following the openings of commercial fishing the mean weight dropped dramatically to .50 kg (1.10 lbs) in 1975. During the same period carp increased from .32 kg (.70 lbs) to .50 kg (1.10 lbs) then declined to .32 kg (.70 lbs) while river carpsucker rose and stabilized from .27 kg (.59 lbs) and .42 kg (.93 lbs) from 1972-75.

Des Moines River below dam

Corps of Engineers' operating procedure specifies a minimum low flow of 300 cfs in the Des Moines River below Red Rock Dam at Ottumwa. Low flow augmentation is one of two authorized project purposes, the other

Table 27. -- Commercial fish harvest per hectare (acre)* at Lake Red Rock, Iowa for period 1974-1979

Species	Year													
	1974		1975		1976		1977		1978		1979		Total	
	kg/ha	lbs/ac	kg/ha	lbs/ac	kg/ha	lbs/ac	kg/ha	lbs/ac	kg/ha	lbs/ac	kg/ha	lbs/ac	kg/ha	lbs/ac
Buffalo	106.7	95.2	122.0	108.8	74.1	66.1	42.7	38.1	46.1	41.1	50.6	45.1	73.6	65.7
Carp	14.7	13.0	7.6	6.7	4.8	4.3	3.0	2.7	2.5	2.2	15.5	13.8	8.0	7.1
Drum	1.4	1.3	0.9	0.8	0.3	0.3	0.7	0.6	0.4	0.4	0.7	0.6	0.8	0.7
Carpsucker	0.0	0.0	0.1	0.1	2.0	1.8	1.9	1.7	1.0	0.9	1.0	0.9	1.0	0.9
Total	122.8	109.5	130.7	116.4	81.1	72.4	48.3	43.1	50.0	44.6	67.7	60.4	83.4	74.4

* Based on an average conservation pool of 3,622 ha (8,950 ac).
Source: James Mayhew, Superintendent of Fisheries, ICC, pers. comm., 1981

Table 28. -- Estimated value of commercial fish harvest at Lake Red Rock, Iowa for period 1974-1979

Species	Years											
	1974		1975		1976		1977		1978		1979	
	¢/lb	Estimated value	¢/lb	Estimated value	¢/lb	Estimated value	¢/lb	Estimated value	¢/lb	Estimated value	¢/lb	Estimated value
Bigmouth buffalo	.19	$161,808	.20	$194,726	.24	$141,928	.26	$ 88,803	.22	$ 80,908	.22	$ 88,708
Carp	.05	5,860	.05	3,027	.05	1,906	.05	1,209	.09	1,756	.09	11,149
Carpsucker	.08	919	.05	40	.05	803	.05	778	.09	693	.07	560
Drum	-	-	.08	600	.11	253	.10	500	.10	385	.12	664
Total value	-	$168,587	-	$198,393	-	$144,890	-	$ 91,290	-	$ 83,742	-	$101,081

Source: James Mayhew, Superintendent of Fishries, ICC, pers. comm., 1981

being flood control. Accommodation of the low flow requirements for the Des Moines River were transferred to the Saylorville project (12), viz:

> While Saylorville Dam is under construction, the minimum flow at Ottumwa, 300 cfs, will be maintained by flow augmentation from the Lake Red Rock Conservation Pool. When Saylorville is completed, both the 200 cfs minimum at Des Moines and the Ottumwa minimum of 300 cfs will be supplied from Saylorville Lake.

The rapid silting of Lake Red Rock reduced the storage capacity by 30 percent in the first 10 years of operation (18). This has created storage problems for the low flow augmentation. The rapid loss of storage also adversely affected production of the aquatic community. To accommodate the loss of storage, the CE proposed increasing the normal pool elevation at Red Rock (op. cit.), viz:

> In order to help maintain adequate water in the Des Moines River for downstream consumers, a minimum release of 300 cfs has been maintained from Red Rock Dam, except during a period of extreme drought in early 1977. In February, 1977, minimum outlow was reduced to 200 cfs when the pool level fell to an elevation of 719.68 feet. This drawdown of the lake provided the impetus for raising the conservation pool to elevation 728 in order to maintain greater low flow augmentation capability. In February, 1977, when the drawdown occurred, Saylorville Dam was not yet in operation. Had Saylorville been operational the drawdown at Lake Red Rock would have been greatly reduced.

Few data are available to permit a definitive analysis of the fish community changes which have occurred in the Des Moines River below the Red Rock project. In 1976, the ICC conducted a brief investigation to determine if angler's complaints of a reduced channel catfish fishery in the river were valid. The resulting report included several observations comparing with, and without-project conditions. The perti-

nent sections of this report follow (29):

> Population sampling with hoop nets and slat traps was conducted for seven, 5-day periods, between May 1 and the middle of October, 1976. Netting was conducted in two areas simultaneously by two crews, one from the Research Branch and one from Management. Areas checked were the Austin-Roberts Park area near Keosauqua, and an area approximately three miles upstream from Ottumwa. Each crew fished six, 3/4 inch bar mesh baited hoop nets and six baited slat traps. Generally nets were raised daily with all fish being enumerated. Subsamples were measured and weighed. Spines were collected from a subsample of channel catfish for age-growth determination. Age and growth determination was accomplished by the Research Section. Electrofishing gear, pound nets and seine were utilized to supplement previous sampling method.
>
> A creel survey was conducted twenty-nine man-days during June, July and August, with the area covered running from Croton to Red Rock Dam. The creel was conducted by boat or vehicle, with travel on the river restricted during the latter part of the season due to low water levels. During the survey, anglers were interviewed and catch checked to determine angler success and species composition of the take.
>
> Water quality data was obtained from the Ottumwa Municipal Water Treatment Plant, the U.S. Corps of Engineers and the U.S. Geological Survey. Information from other sources were reviewed.

Figure 2 shows the general location of the Keosauqua and Ottumwa sampling stations. Results of the ICC's test netting is summarized in Table 29. The creel survey data are presented in Table 30, and a portion of the narrative follows:

> Fifty percent of anglers harvest was channel catfish with the remainder of the harvest consisting of carp (9%), drum (8%), flathead catfish (3%), white bass (8%), bullhead (6%), crappie (12%) and walleye (4%).
>
> Sixty-seven percent of the channel catfish were taken during June, with 65% of the total harvest occurring during this month. Size of channel catfish checked

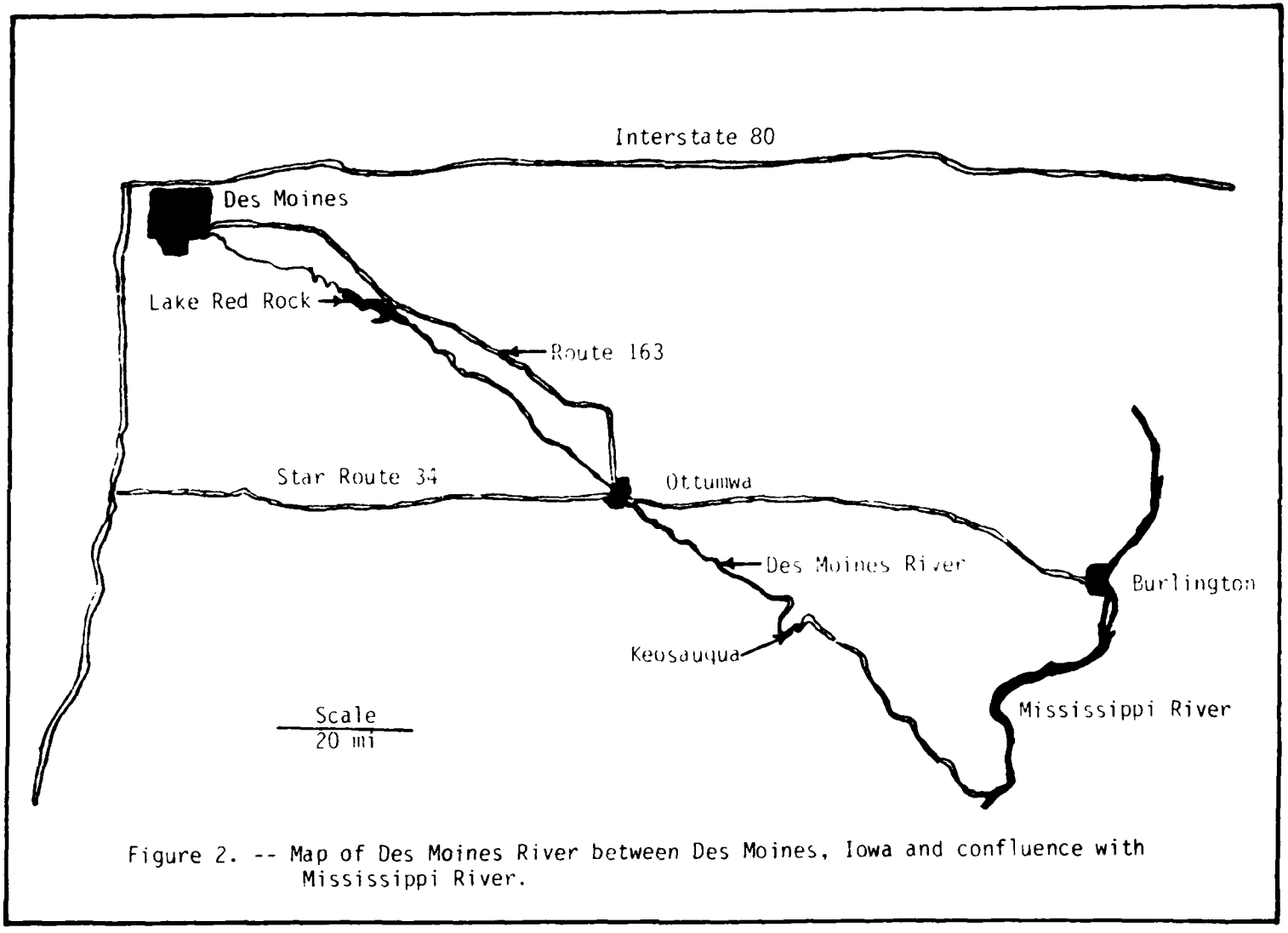

Figure 2. -- Map of Des Moines River between Des Moines, Iowa and confluence with Mississippi River.

Table 29. -- Comparison of hoop net and box trap sampling of Des Moines River comparing pre-project and post-project values

Parameter	Red Rock area (Knoxville) 1966	Red Rock area (Knoxville) 1967	Keosauqua area 1976	Ottumwa area 1976
No. channel catfish/net day*	10.2	18.0	6.0	2.4
Species composition of catch (%)				
Channel catfish	86	88	82	45
Carp	11	6	14	51
Other	3	6	4	4

* Using hoop nets and box traps
Source: Reference No. 29

Table 30. -- Des Moines River creel survey data, 1976

	Anglers checked	Hours checked	Fish checked	Catch/ man-hour
June	172	413	149	.36
July	121	236	54	.23
August	59	124	28	.23
Total	352	772	231	.30

Source: Reference No. 29

ranged from 7-21 inches, with an average length of 12 inches.

Perhaps the most interesting and informative data presented in this ICC report was the discussion of water quality which occurred in the Des Moines River after completion of the Red Rock project, viz:

> Numerous sources of information were reviewed to determine changes which have occurred in physical, chemical and biological characteristics of the river since the advent of Red Rock Dam. Data obtained from the Ottumwa Municipal Water Treatment does provide some interesting information regarding the changes in temperature and turbidity since the closing of the gates at Red Rock Dam.
>
> A decrease in both water temperature and turbidity can be noted. Average and maximum water temperatures have dropped about two degrees during the latter eight year period (post Red Rock). Maximum and average turbidity (as measured in Jackson turbidity units) during this same period has decreased to approximately one-third of its former level.

The ICC's water quality data are reflected in Table 31.

Conclusions reached by the investigators were that fish population comparisons between periods were not possible, viz:

> It was planned to compare netting success [fish/net day] of past studies with current data as a means of determining relative density of the channel catfish populations in the Des Moines River. For this reason, netting methods were maintained similar to those previously used. The variation in this year's data between areas and difference in netting success between successive years in the previous study precludes the possibility of making any meaningful comparison of channel catfish population densities based on netting success. Some of the possible causes for this variation in success are discussed by Mayhew and Mitzner in the 4-11-R-2 commercial fishing project report. One of the factors discussed in the direct correlation between high turbidity and high net success. It has been noted that turbidity is about one-third of its previous level, which may be

Table 31. -- Des Moines River turbidity (Jackson turbidity units) and water temperatures (daily readings) at Ottumwa Municipal Water Treatment Plant, 1960-1976

Parameter	Period 1960-68	Period 1969-76
Temperature		
Average annual maximum (°F)	81.3	79.1
Range	77-86	75-84
Average for June (°F)	72.8	71.2
Range	66-80	67-77
Average for July (°F)	81.2	78.1
Range	77-86	72-84
Average for August (°F)	78.4	76.9
Range	77-81	75-79.4
Turbidity		
Average minimum	18	17
Average maximum	1,194	328
Average	313	117

Source: Reference No. 29

a factor in explaining the low catch during the current year.

Growth of channel catfish in 1976 was similar to that which occurred in 1966 and 1967 with fish reaching 12 inches in length during their fifth year. This would indicate that the channel catfish presently have much the same relationship with the food supply as previously existed; however, there is no way of knowing whether this "balance" exists at a higher, lower or equal population level.

Some anglers are convinced that the channel catfish population has decreased during the past few years. The cooler water and decreased turbidity that has occurred during the past seven years would favor other fish (crappie, walleye, etc.) over channel catfish and increase competition with these species; however, the results of all sampling indicate little change in species composition since the 60's, at least in the Keosauqua area. Channel catfish catch per angler hour was .15 for the census period, considerably below the mean catch of .25 found by Harrison in his studies of the Upper Des Moines River area, which lends some credence to angler complaints.

Nothing in the data collected in the past, or this year, indicates that angling for channel catfish would be improved by the stocking of additional fish.

Fishery Resources -- Evaluation of Planning Input

Review of the pre-construction planning documents pertaining to fisheries development at the Red Rock project indicates that the effort was most cursory in scope. The lead agency was considering building the project with one of three different sized lakes. Both the ICC and the FWS sought to have the largest possible lake built. That was essentially the only recommendation that was provided by the conservation concerns in 1960 when planning was underway.

The project was designed to provide flood control benefits to the lower

Des Moines River valley and downstream along the Mississippi River. The lake is fed by an enormous watershed; a watershed which is largely under row crop cultivation. This combination of conditions results in a fluctuating, frequently turbid lake which provides less than optimum fishery conditions.

The FWS currectly foresaw that the resulting impoundment would harbor dense populations of non-game species resident to the free-flowing river, and further anticipated that to establish and maintain a reasonably attractive sport fishery at Lake Red Rock would require intensive management. However, no design or operational assistance was sought from the CE by the conservation agencies, and essentially none has been provided. Without appropriate management, the Lake Red Rock fish community would likely be comprised of a far less attractive recreational fishery than is now the case. Although somewhat speculative, it is entirely probable that in the absence of the limited fish management program currently maintained by the ICC, the fish community of an unmanaged Lake Red Rock could well have proven to be a public relations liability to the project's sponsors and to the CE.

Sport fish management by the ICC has been limited to stocking desirable species including largemouth bass, walleye, and northern pike, and to supervision of the commercial fishing program.

Fish produced in Lake Red Rock, which functions in this instance somewhat as a nursery area, move upriver from the lake and downstream through the dam into the tailrace, depending upon season of year and

flow conditions. Concentrations of fish in these areas attract unusually heavy fishery pressure. In 1971, the tailrace area of only a few acres supported 89 percent of the total angling use of the Lake Red Rock project. Only 5,334 angler-trips were attracted to the 3,622 ha (8,950 ac) lake, or 1.5 angler-trips/ha (0.6 trips/ac). CE-installed facilities in the Lake Red Rock tailrace greatly facilitate heavy angler use.

The 1971 ICC creel survey generated an angler-use figure of 48,538 visits while the FWS predicted angler-use at 72,000 angler-days, annually (Table 32). Although the reported use in 1971 was significantly below the prediction, several factors that bear on angler-use make this apparent over-estimate of angler effort insignificant. Completion of the Saylorville project on the Des Moines River above Des Moines, Iowa will reduce the frequency and extent of fluctuation at Lake Red Rock. With the addition of the Saylorville project to the system, an opportunity may exist to manipulate the water level at Red Rock to create more favorable conditions for recreational fishing. A more stable water level would allow shoreline stabilization activities such as seeding and revegetation.

Raising the conservation pool elevation at Lake Red Rock will enlarge the lake and, thus, potentially increase the production of fish. These factors may provide improved fishing conditions at Lake Red Rock. If so, angling pressure could increase to the levels predicted in the 1960 FWS report. The ICC's projection of approximately 109,000 angler

Table 32. -- Predicted (1960) and actual (1971) recreational angling effort at Lake Red Rock, Iowa

Predicted angler-days (1960)		Actual angler-days (ICC survey, 1971)		
FWS	ICC	Lake	Tailrace	Total
72,000	108,893	5,334	43,204	48,538

Source: References 3, 4, and 25

visits may well prove to have been too high.

Unfortunately, no support data could be located to trace the procedures employed by the conservation agencies to develop their use projections. The FWS were cognizant of the growth in angling participation in the area of influence following construction of Coralville Reservoir in Iowa. Consideration of previous experience at the Coralville project was certainly a reasonable point of departure for the Red Rock planning process.

The planning agencies did not address the Des Moines River fishery below the project. The lead agency's proposal to maintain a 300 cfs minimum release below the dam was apparently considered by the conservation agencies to be an adequate accommodation of the river fishery. Although turbidity levels were believed to have been reduced in the lower river to levels approximately one-third the pre-project levels, no measurable changes in species composition of the river fishery were noted by the ICC.

SUMMARY

Red Rock Dam and Lake Red Rock are located on the Des Moines River 230 km (143 mi) above the river's confluence with the Mississippi River and 96 km (60 mi) below Des Moines, Iowa. The project was authorized by Congress in the Flood Control Acts of 1938 and 1944 to provide flood control and low flow augmentation. The authorized conservation pool covers 3,622 ha (8,950 ac) but the project has recently been operated with a conservation pool of 4,634 ha (11,450 ac) to accommodate the flow augmentation storage lost due to sedimentation. A total of 19,267 ha (47,608 ac) were acquired in fee title for project purposes.

The Red Rock project is located in fertile, farming country and most of the surrounding lands are under row crop cultivation. Formation of Lake Red Rock caused the permanent inundation of 4,634 ha (11,450 ac) or approximately 47 km^2 (18 mi^2) of land, and further causes the occasional, temporary inundation of additional lands within the flood zone. The reservoir has resulted in a 37 percent reduction in the amount of cropland within the study area. Significant losses of floodplain woodland, totaling 1,672 ha (4,130 ac) resulted from project construction. On the other hand, the Red Rock Lake project created a large, public holding with a diverse plant community of moisture resistant annuals and perennials and upland forest habitat, creating wildlife habitat unique to this area of Iowa.

Wildlife

Comparison of pre-project and post-project aerial photographs failed to reflect quantifiable alteration of habitat types for a distance of 52.3 km (32.5 mi) below the dam following completion of the Red Rock project.

Mitigation activities at the Red Rock project have been greatly affected by recent changes in CE policies and also by changes in project conditions, associated largely with sediment storage. As a result of these unforseen fundamental changes, actual post-impoundment conditions for wildlife were only poorly perceived and accommodated during the pre-construction planning period.

When the Red Rock project was proposed, the ICC viewed the possible construction of a large lake (essentially the larger the better) at the site as an attractive possibility. The ICC's position on land acquisition was purely reactive in nature. No specific lands were requested beyond those rather extensive acquisitions planned for flood storage purpose by the lead agency. The opportunity to diversify wildlife habitat, with emphasis on waterfowl enhancement was welcomed by the ICC from the beginning of project plan formulation.

In recent years, management effort has emphasized the creation of habitat to attract migrating ducks. To accommodate this basic objective, the ICC has used revenues generated under newly authorized "Condition five" of the license agreement with the CE, to create sub-impoundments.

Development of upland forest has received less emphasis to date. However, in the long term, the availability of sustained funding should allow the ICC to implement the desired upland management program.

Lake Red Rock has silted rapidly, with a 30 percent loss of reservoir storage capacity recorded between 1969 and 1979. This loss of capacity persuaded the CE, with FWS and ICC concurrence, to raise the conservation pool from the authorized level of 221 m (725 ft) to 222 m (728 ft). No note was taken of the potential silt problem in pre-construction documentation.

Two creditable recommendations were provided by the FWS early in the project development phase. These were to preserve surplus buildings for use by the ICC in their game management activities, and a request for project boundary monumentation.

To a great extent, present habitat conditions reflect natural vegetative successional influences resulting from the conversion of privately-owned bottomlands and agricultural lands to a large public holding surrounding a fluctuating reservoir. Natural plant succession, particularly within the lower portion of the flood storage pool, has provided brushy habitat that, when not inundated, provides valuable cover and nesting habitat for many wildlife species.

Current opinion of local ICC wildlife biologists is that the pre-project deer herd was probably slightly smaller or slightly larger (around 280 animals) than the current herd. No quantitative data were provided

regarding pre-project conditions or expected post-project conditions for upland game, or furbearers. A recent analysis reported ICC biologists' opinions that pheasants were benefitted by the project, while the Red Rock public lands are capable of supporting fewer quail than before construction due to land use changes.

Turkeys were not found in the project site when Red Rock was being planned and no mention of past, present or potential use of project lands by turkeys was contained in any pre-construction report. Turkeys were recently released (1981) on the Red Rock Management Area. Many reservoir projects result in the elimination of bottomland hardwood. As a consequence, squirrel populations suffer damage from such projects and the Red Rock project was no exception. Rabbits were present in low number prior to project construction and were expected to suffer no serious loss. However, informed opinion currently assumes the loss of cropland and other habitats and edge have adversely affected rabbit populations. Trapping success remains high for raccoons, other furbearers and current opinion appears to be that the project benefitted most aquatic and terrestrial furbearers.

Although duck-use averaged 45 times greater in the years immediately following impoundment, and goose-use was 18 times greater (1967 vs 1969-1974), actual long-term use of this facility by waterfowl will not be apparent for several years following creation of the managed sub-impoundment and possible creation of a new goose flock currently under development by the ICC.

In 1960, the FWS expected approximately 12,000 hunter-days to occur on the project for deer, upland game and waterfowl. This estimate was based upon conditions existing in the absence of wildlife-related management. This was 67 percent more hunting effort than the 7,200 hunter-days actually estimated from field surveys conducted between September 18, 1979 and February 13, 1980.

Fisheries

Planning for fisheries development at the Red Rock project was almost non-existent. Both the ICC and the FWS sought to have the largest possible lake built. That was essentially the only recommendation that was provided by the conservation concerns in 1960 when planning was underway.

The FWS correctly foresaw that the resulting impoundment would harbor dense populations of non-game species, and further anticipated that to establish and maintain a reasonably attractive sport fishery at Lake Red Rock would require intensive management. However, no design or operational assistance was sought from the CE by the conservation agencies, and essentially none has been provided.

Sport fish management by the ICC has been limited to stocking desirable species including largemouth bass, walleye and northern pike, and to supervision of the commercial fishing program. Without this limited management, the Lake Red Rock fish community would likely be comprised of a far less attractive recreational fishery than is now the case. Although somewhat speculative, it is entirely probable that in the

absence of the limited fish management program currently maintained by the ICC, the fish community of an unmanaged Lake Red Rock could well have proven to be a public relations liability to the project's sponsors and to the CE.

The 1971 ICC creel survey generated an angler-use figure of 48,538 visits while the FWS predicted angler-use at 72,000 angler-days, annually. According to the ICC's creel survey, the tailrace supported 89 percent of the total angler-use of Lake Red Rock. Only 5,334 angler trips were attracted to the 3,622 ha (8,950 ac) lake, or 1.5 angler trips/ha (0.6 trips/ac). CE-installed features beneficial to anglers in the tailrace greatly facilitate the heavy angler-use.

The planning agencies did not address the Des Moines River fishery below the project. The lead agency's proposal to maintain a 300 cfs minimum release below the dam was apparently considered to be an adequate accommodation of the river fishery. Although turbidity levels were believed to have been reduced in the lower river to levels approximately one-third as high as pre-project levels, no measurable changes in species composition of the river fishery were noted by the ICC.

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*U.S. GOVERNMENT PRINTING OFFICE : 1982 0-391-604/8740


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